803-GS-RAR-BPO-BALLOONS-01H

RISK ANALYSIS REPORT

FOR

Balloon Launch Vehicles

Effective Date
March 2016
Version 01H

803/Safety Office

Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia 23337

National Aeronautics and Space Administration

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CHANGE HISTORY LOG

REVISION	EFFECTIVE DATE	DESCRIPTION OF CHANGES
-	October 1, 2010	Original Issue
A	October 13, 2010	Added MIP pyrotechnic systems information (Enclosures 10 – 14); added “CSBF Crew Chief &/or the Campaign Manager” to Section 2.2; Added “Launch Vehicle” to last block in Table 6.1; Increased Danger Area radius around Launch Spool from 15.25 meter (50 ft) to 30.5 meter (100 ft.) in Section 6.0; Changed overall Danger Area based upon newly received flight train schematics; Corrected errors in Hazard Reports #12 & 22; Changed Hazard Report #23 from LV “stalls” to LV “breaks down/becomes inoperative.”
B	October 25, 2010	Modified to incorporate PLDA
C	November 10, 2010	Updated per the internal review suggestions
D	March 14, 2011	Added HAR concerning crane per BPO request
E	March 22, 2011	Modified HAR concerning crane per BPO request
F	May 17, 2011	Added reference to BTS Report
G	August 21, 2015	Updated electrical schematics, cleaned up formatting, removed not applicable documents from section 12, updated to RSM 2002C, added remote site rented crane, updated section 7, reviewed and updated HRs updated MIP info, updated links to WFF Safety, updated Figure 1 with 7 seconds cutters, removed ELS that was for one mission only and updated pressure danger calculation
H	March 4, 2016	Edited sections: 1.0, 15.0 – changed and removed references to payload/recovery 2.2, 2.3, 2.4, 2.5 edited short cut TABLE 15.1 – removed FS HAR 17 Edited * to **, *** and **** Edited 3.1 table and ENCLOSURE 1 to indicate that rip-stitch cutter is only used for payloads ≥4000 lbs. Reviewed and edited all HARs. Edited LDEM information in section 6.0. Updated PLDA to 315 ft. following LV. Updated table. After review, updated Enclosure 3 sections 2 and 3. Updated WFF folder location. Edited usage of PSEMC cutters Updated Balloon Rip Line Cutter Updated Tow Balloon info Added ISM Band Transmitter for SPB Tow Balloon

TABLE OF CONTENTS

1.0 INTRODUCTION

This Risk Analysis Report (RAR) contains technical information and describes the ongoing effort required for system safety verification and certification of Balloon missions. The purpose of this document is to identify hazardous systems associated with Balloon launch vehicles, compare the risk potential versus control techniques and demonstrate via a Risk Assessment Code Matrix the feasibility of safely conducting the mission.

2.0 PYROTECHNIC SYSTEMS & ELECTRICAL INHIBITS

Balloon missions may utilize pyrotechnic devices to perform the following functions:

- Collar System Deployment
- Balloon Termination
- Balloon Rip Line Cutter
- Rip Stitch Separate (from the parachute)
- Parachute/Payload Separation
- Tow Balloon Separation

The electrical characteristics of Electro-Explosive Devices (EEDs) used to initiate the pyrotechnic functions shown above are listed in Enclosure 1. The electrical inhibits for the corresponding initiation circuits are described in the paragraphs below.

2.1 Collar Release System

The **CSBF Collar Release Firing Circuit** (Enclosure 2-1) initiates a guillotine that severs a small steel cable which initiates mechanical separation of the collar from the balloon during launch. The collar guillotine squibs, two Pacific Scientific Energetic Materials Company (PSEMC) 6801 series, are staged and electrically connected toward the end of balloon inflation and very close to the time of launch. Prior to electrical connection, the guillotines are protected by shorting plugs. The guillotines are fired during the launch operation, prior to payload release, just a few minutes after they are connected. The collar guillotines, when staged and electrically connected to the firing circuit, have the following inhibits:

A. Manually installed safe plugs which isolate the initiators from the initiating circuitry and provide a short on the initiator bridge wires (prior to initial arming).
B. Manually installed test plugs which provide a secondary short (primary shorting is accomplished via a 15K drain resistor) across the CDI circuitry (prior to initial arming and only when the initiating relay is in the fire position).
C. For the RF activated initiator, shorted contacts on the initiator relay which isolates the initiator from the pyrotechnic battery. In addition, shorted contacts on the initiator relay provide a short on the bridge wires.
D. For the Altitude activated initiator, open contacts of a 10Kft altitude switch between the pyrotechnic battery and the initiator isolate the initiator from the pyrotechnic battery.
E. The radio command to send the collar command is on a restricted frequency and requires a radio that can transmit Dual-Tone Multi-Frequency (DTMF) tones. The

command is sent by a designated control tower operator when instructed by two separate observers on the launch pad.

The Collar Release initiator firing circuit can also be found at \\Wff-lynx\Code803NEW\Documents\Working Documents\Ground Safety\Firing Circuits\Balloons.

2.2 Balloon Termination System

At the conclusion of a successful flight or, in the event the vehicle performs abnormally and exceeds pre-established safety limits, command separation of the Balloon and parachute system will be initiated by the CSBF Campaign Manager through the use of the Balloon Termination System. The terminate guillotines are initiated from the Remote Firing Unit (RFU) located at the top of the parachute. The firing circuitry of the RFU (UTP/RFU Enclosures 2-2 and 2-3 Micro Instrumentation Package (MIP) RFU enclosure 2-10) initiates either of two terminate guillotines on the terminate fitting, located just above the RFU. When either guillotine is fired, a steel cable is cut which separates the terminate fitting and allows the parachute to fall away from the balloon and descend to earth or release the balloon from the launch vehicle prior to payload release in the case of a launch abort. The firing circuitry in the RFU can be initiated by several firing circuitry subsystems in the flight train: (1) Universal Terminate Package command system (Enclosures 2-4 and 2-5); (2) the Balloon Burst Detector (circuitry shown in Enclosure 2-2); (4) the MIP/LDB Terminate & Tow Balloon Separate, MIP Burst Detector, MIP SAPR (circuitry shown in Enclosures 2-10 through 2-14); and (3) An aneroid switch set to detect low altitudes (shown in Enclosure 2-4). The terminate guillotines are electrically connected immediately prior to inflation, approximately one hour before launch

The terminate guillotines, when staged and electrically connected to the firing circuit have the following inhibits:

A. Terminate circuitry is protected by an electrical arm/fire system which prevents the guillotine from firing until two separate commands are received.
B. Ground station software prevents terminate commands from being sent to power the firing circuit until two separate manual operations are completed. [Long Duration Balloon (LDB) GSE requires multiple entries when activating flight critical circuitry, e.g., the operator is asked, “Are you sure you want to send this command”. Portable command systems (bitty boxes) and the aircraft seat pack command systems have separate arm and fire buttons which must be must be depressed simultaneously to send the command. Conventional ground stations require verification by a second (human) operator.]
C. An aneroid switch set to 10,000 feet disables the burst detector circuitry until the system reaches that altitude.

Initiation of the terminate guillotines is accomplished via either of two PSEMC 6803 series squibs. The MIP and/or the UTP/RFU firing circuitry incorporates the following inhibits:

A. Manually installed Safe plugs which isolate the initiators from the initiating circuitry and provide a short on the initiator bridge wires (prior to initial arming).

B. Manually installed test plugs which provide a secondary short (primary shorting is accomplished via a 15K drain resistor) across the CDI circuitry (prior to initial arming and only when the initiating relay is in the fire position).
C. For all three initiator circuits, shorted contacts on the initiator relays provide a short across the bridge wires. Open contacts on these same relays isolate the initiators from the respective CDI firing circuits.
D. For the primary and backup initiator circuitry, open contacts on the Arm/Safe relay(s) that provide isolation between the CDI charging batteries and the initiator relay(s).
E. For the Burst detect initiator circuitry, open contacts on dual non-redundant 10K altitude switch which isolate the pyrotechnic battery from the initiator relay.
F. For the minimum altitude aneroid circuitry, open contacts on two altitude switches (~60Kft and ~70Kft) isolate the CDI firing circuitry from the pyrotechnic battery.

More information concerning the Balloon System, BTS, is covered in a separate document, Balloon Flight Termination System Report, 820-FTSR-2011-1. The Balloon Termination System firing circuits also can be found at \\Wff-lynx\Code803NEW\Documents\Working Documents\Ground Safety\Firing Circuits\Balloons.

2.3 Balloon Rip Line Cutter

The Balloon Destruct Line Guillotine is a time delay (7 seconds +/- 20%) Tech Ordnance #210227, lanyard activated (30 lbs. of tension, +/- 20lbs.) stainless steel cable cutting device. A nylon cord is attached to a panel in the balloon and the other end of the nylon cord is attached to a steel cable. The steel cable goes through the Destruct Line Guillotine and the steel cable is attached to the terminate fitting. Seven seconds after the mission has been terminated, via the balloon termination guillotines, the device severs the 3/32" diameter stainless steel cable (within manufacture specification for this cutter). The device itself utilizes a standard M42 primer to initiate cutting of the steel cable. The device has the following mechanical inhibit:

A physical SAFE plug which prevents mechanical movement of the lanyard. The SAFE plug is removed just prior to launch.

The initiator is lanyard activated. It has no power source or firing circuit. See Figure 1.

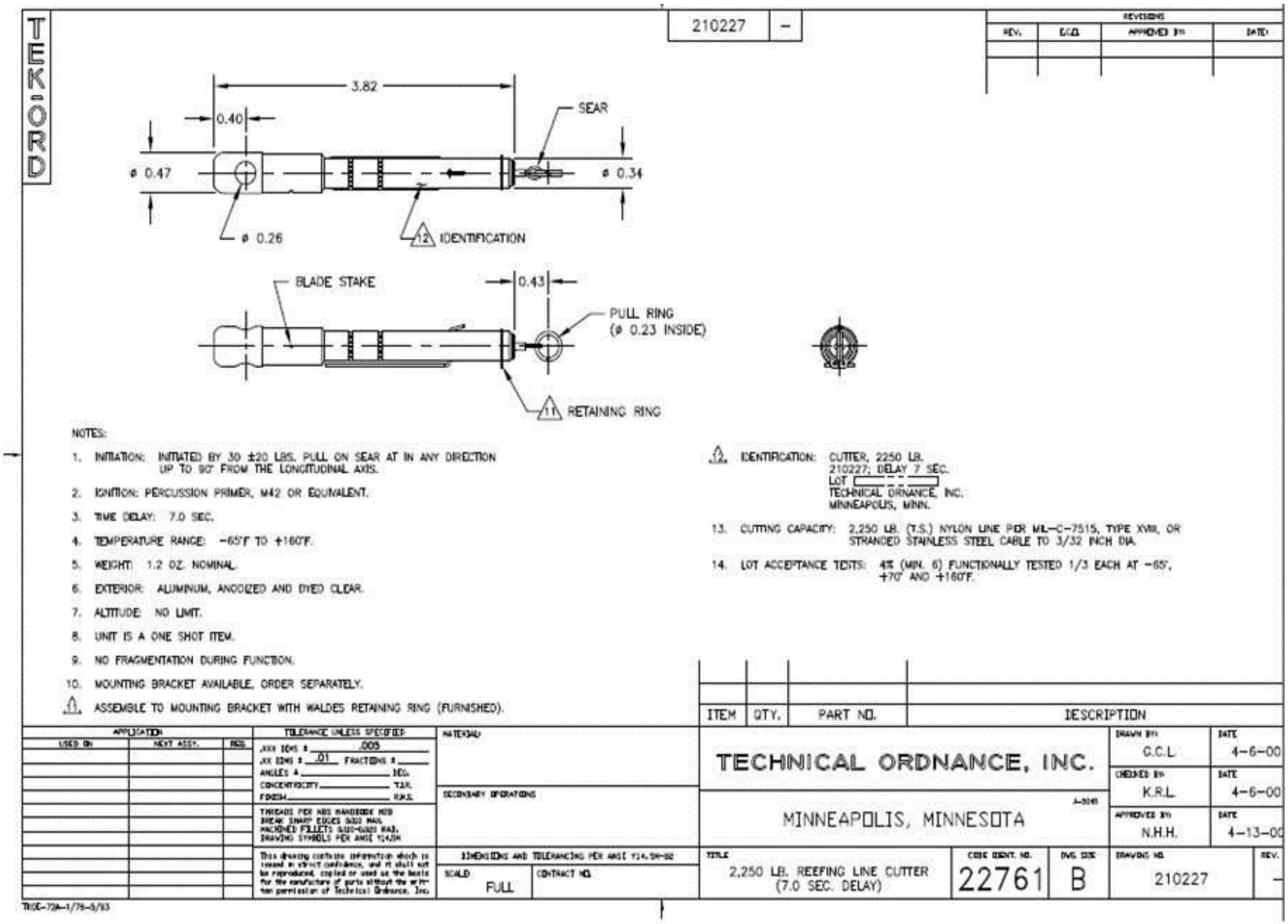


Figure 1 – Rip Stitch and rip line cutter

2.4 Rip Stitch Line Cutter

The Rip Stitch line cutter is a time delay (7 second +/-20%) Tech Ordnance #210227, lanyard activated (30 lbs. of tension, +/- 20lbs.) nylon cord cutting device. A nylon cord is attached to the bottom of the rip stitch and the top of the terminate fitting. Seven seconds after termination via the balloon termination guillotines, the device severs the nylon cord. The device has the following mechanical inhibit.

A physical SAFE plug which prevents mechanical movement of the lanyard. The SAFE plug is removed just prior to launch.

The initiator is lanyard activated. It has no power source or firing circuit. See Figure 1.

2.5 Parachute/Payload Separation

As soon as the payload impacts the ground, the parachute is released via two PSEMC (Two if equipped with GAPR systems) 6802 series guillotine cutters in the Payload Release System. When either guillotine is fired, a steel cable is cut that releases a mechanical clamp that releases the parachute from the payload to prevent dragging in windy conditions. The firing circuitry for this system is shown in Enclosures 2-9 or in the case of the MIP enclosure 2-14.

Parachute release can be initiated with discrete line of sight commands sent directly from the tracking aircraft by the Semi-Automatic Parachute Release (SAPR) system or by the optional Gondola Parachute Release (GAPR) system. The GAPR system is flown primarily on Long Duration Balloons (LDB) flights and flights that will utilize nighttime terminations. The firing circuitry for these systems is shown in enclosures 2-6, 2-7 and 2-8.

The SAPR and GAPR are initiated by a series of discrete commands sent from the line of sight ground station, the tracking aircraft command system or over the horizon links through Tracking and Data Relay Satellite System (TDRSS). For over the horizon links Iridium satellite systems is also a possibility. The SAPR requires that several commands be sent and received after the system is on the parachute. The GAPR is an automatic parachute release system activated prior to termination.

The parachute release guillotines when staged and electrically connected to the firing circuit have the following inhibits:

A. Shorting plugs that are in place until electrical connection immediately prior to inflation (approximately one hour before launch).
B. Electrical arm/fire system requiring receipt of two or more independent command to power the circuit.
C. Ground station software that prevents “terminate” commands from being sent to power the firing circuit unless two separate manual operations are completed. LDB GSE requires multiple entries when activating flight critical circuitry. Portable command systems (bitty boxes) and the aircraft seat pack command systems have separate arm and fire buttons which require simultaneous depression for the command to be sent. Conventional ground stations require verification by a second human operator.

In addition to the electrical inhibits in the firing line, ground personnel are protected, in the case of a premature initiation event, by a set of safety cables which are held in the load train by a set of pins that must be pulled by a motor. Inadvertent firing of the ordnance would have no effects because without the pins being pulled, the flight train would continue to be supported by the safety cables. Additionally, a clutch mechanism in the motor assembly makes it impossible for the motor to develop the necessary torque to pull pins if the ordnance has been fired.

The MIP or the UTP Chute Cutaway firing circuitry incorporates the following inhibits:

A. Manually installed Safe plugs which isolate the initiators from the initiating circuitry and provide a short on the initiator bridge wires (prior to initial arming).

B. Manually installed test plugs which provide a secondary short (primary shorting is accomplished via a drain resistor) across the CDI circuitry (prior to initial arming and only when the initiating relay is in the fire position).
C. Shorted contacts on the initiator relays which provide a short across the bridge wires. Open contacts on these same relays isolate the initiators from their respective CDI firing circuits. This applies to all three initiator circuits (Chute Cut, SAPR and GAPR).
D. Open contacts on the Safe/Arm relay(s) which provide isolation between the CDI charging batteries and the initiator relay(s). This applies to all three initiator circuits (Chute Cut, SAPR and GAPR).
E. Dual independent tilt angle monitors must both agree in order for initiation of the firing circuitry (GAPR and SAPR).
F. Dual inline altitude switches preclude arming above 30Kft altitude (GAPR).

The Parachute/Payload Separation firing circuits can also be found at \\Wff-lynx\Code803NEW\Documents\Working Documents\Ground Safety\Firing Circuits\Balloons

2.6 Tow Balloon Separation

For applications where a tow balloon or launch tensioned restraint system is utilized as part of the launch process – SPB Tow Balloon, LDSD Restraint system, etc., a MIP Based Terminate system is used to fire pyrotechnics which release the tow balloon from the APEX of the balloon, or cabling at some attachment point to the flight system. See section 2.2 for a detailed description of the inhibits and command systems utilized for this MIP Based unit.

2.7 Other Payload Pyrotechnic Functions

Payload Pyrotechnics are not standard to the balloon vehicle. These devices, if any, and their initiation circuits, will be addressed in the mission specific Ground Safety Data Package (GSDP) / Plan (GSP).

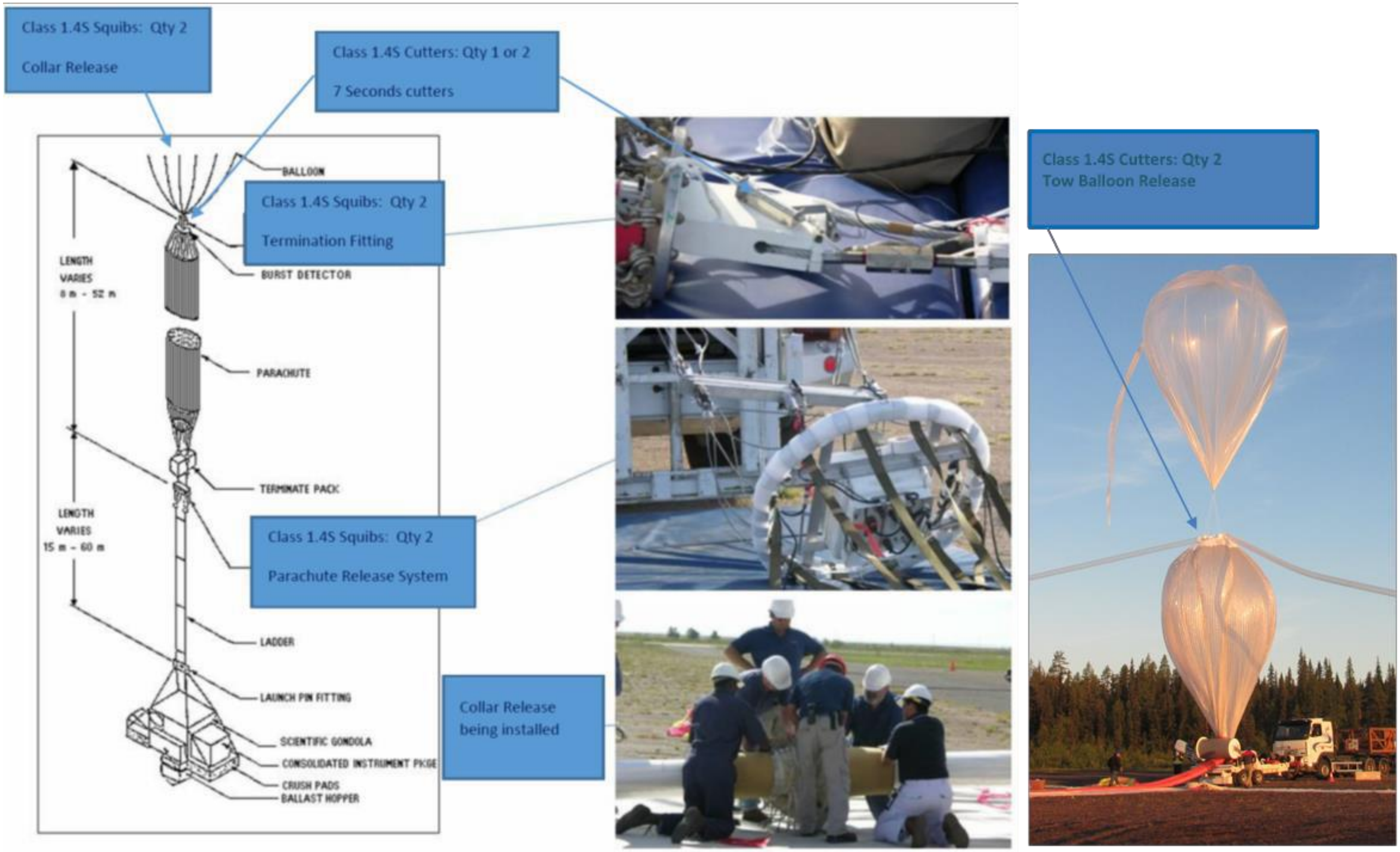


Figure 2 – Location of Hazardous Systems / Pyrotechnic Devices

3.0 HAZARDOUS EXPLOSIVE SYSTEMS

This section includes the Balloon explosive items, Prelaunch and Launch Danger areas.

3.1 Explosive Items

The following table lists explosive items contained in Balloon missions and their associated hazards, in accordance with NASA Standard 8719.12.

EXPLOSIVE SYSTEM	HAZARD TYPE (CLASS / DIVISION / COMPATIBILITY GROUP)
Collar Release: PSEMC 6801 Guillotine Cutter (2 each)	Moderate Fire, No Blast (1.4S)
Balloon Termination (Balloon Separation): PSEMC 6803 Guillotine Cutter (2 each)	Moderate Fire, No Blast (1.4S)
Balloon Rip/Destruct Line Guillotine: Tech Ordnance #210227 (1 each)	Moderate Fire, No Blast (1.4S)
Parachute/Payload Separation: PSEMC 6802 Guillotine (2 each)	Moderate Fire, No Blast (1.4S)
Tow Balloon Separation: PSEMC 6802 Guillotine Cutter (2 each)	Moderate Fire, No Blast (1.4S)
RipStitch Release Line Tech Ordnance #210227 (1 each)	Moderate Fire, No Blast (1.4S)

3.2 Danger Areas

The **Pre-Launch Danger Area (PLDA)** for assembled Balloon launch vehicles is defined by 315-ft radius about the Launch Vehicle (LV), plus a 315-ft radius about the Spool / Helium Truck, with non -parallel lines along the Flight Train connecting the outer edges of the two circles.

The **Launch Danger Area (LDA)** for balloons launch vehicles is defined as an additional 500 ft. buffer around the Launch Limit Area (LLA). The LLA is a launch hazard zone in which the launch vehicle can maneuver in order to conduct the balloon launch. The LDA is established when the CSBF BTS is made “hot” by arming of the BTS and balloon inflation begins. Access controls will be established to exclude **ALL** personnel from the LDA with the exception of the mission essential personnel. The LDA remains in effect through balloon launch or until helium is released from the balloon envelope or until the BTS is safed, via command.

The **Launch Hazard Area (LHA)** will be defined by WFF Flight Safety. This area will be defined in the FSP specific to each campaign. The LHA is established prior to balloon inflation. Roadblocks are established prior to balloon release.

The danger areas for RF emitters that may be flown on this vehicle are listed in paragraph 7.0.

Methods of calculating these distances are documented in the Safety Engineering Notes contained in Enclosure 3.

4.0 HIGH PRESSURE SYSTEMS

None are contained onboard the Balloon launch vehicles. High pressure systems in payloads will be addressed in a mission-specific GSDP / GSP. A Helium Truck Inflation System is used at the launch site prior to launch. This system is composed of a truck loaded with helium tanks (isopacks), the pressure regulation system and the inflation hoses/diffusers.

The specifications of the pressure vessel components that are used for balloon launches are listed in the following table.

Nominal Volume (SCF)	Manufacturer	Model #	Operating (Service) Pressure Max (psig)	Proof (Test) Pressure (psig)	Burst Pressure (psig)	Material
1500K – 170K	Helium Tubes (Isopack Trucks) / Various **(1)**	Various **(1)**	~3000 **(1)**	> 5000 **(1)**	~4200 **(1)**	Steel / Composite
N/A	Gas Tube Manifold / Sherwood	430C-N	Tube outlet pressure	6,000	6,000	Forged brass body with brass trim. Aluminum-Silicon Bronze lower stem. Kel-F seat and Teflon packing.
0.4091	High Pressure Hoses / Furon	3R80-80	3500	14,000	14,000	Nylon core tube with braided synthetic fiber reinforcement and polyurethane cover. Meets SAE 100R8.

(1) The helium bulk equipment varies with the individual, and within the individual vender's stock. For example, Praxair supplies the Antarctic helium in Isopacks. Parts of their stock are units previously belonging to J. B. Kelly, and part are from Praxair stock. Air Products Corporation, Inc. supplies the helium to Palestine, TX and Fort Sumner, NM in OTR trailer units. Those units are also from various sources and manufacturers. Nominally, these units have between 8-12 steel tubes – no inserts or overwrap. The units supplying helium in Sweden consist of Liquid Helium dewars and trailers supplied by BOC. In Australia, the helium is supplied by Air Products, Singapore dba as Supra Gas of Sydney. That bulk helium is supplied in composite skids with 7-10 tubes. The indicated pressure values are nominal values for Air Products units supplied to Fort

Sumner, NM. In New Zealand, Helium tanks are CSBF property and are shipped from US for every mission.

The **Danger Areas** for the pressure vessels are as follows:

- For the Helium Truck Inflation Vehicle, the area within a circle of 15 meters (50 feet) radius centered on the vehicle.
- For the Inflation Hose/Diffuser, the area within a circle of 96 meters (315 feet) radius centered on the hose centerline.

5.0 HAZARDOUS CHEMICALS AND CHEMICAL SYSTEMS

None contained in Balloon launch vehicle systems. Hazardous chemicals/systems in payloads will be addressed in a mission-specific GSP / GSDP.

6.0 HAZARDOUS MECHANICAL SYSTEMS

These systems pose critical hazards to personnel:

TABLE 6.1: HAZARDOUS MECHANICAL SYSTEMS*

MECHANICAL SYSTEM	MECHANICAL HAZARD	RESTRAINTS
Balloon Restraining Spool	Stored Energy from Balloon Loads	Mechanical Lever
Tiny Tim Launch Vehicle	Potential Energy from Elevated Payload and Kinetic Energy of Moving Vehicle	Claw & Pin
Mobile Launch Vehicle (MLV)	Potential Energy from Elevated Payload and Kinetic Energy of Moving Vehicle	Truck Plate & Restraint Cables
Remote site, rented crane launch vehicle	Potential Energy from Elevated Payload and Kinetic Energy of Moving Vehicle	Truck Plate & Restraint Cables
The BOSS Launch Vehicle	Potential Energy from Elevated Payload and Kinetic Energy of Moving Vehicle	Truck Plate & Restraint Cables
Flight Train	Stored Energy from Balloon Loads	Restraining Spool and Launch Vehicle

* CSBF documents a Launch Equipment Configuration and Certification (LECC) for each balloon launch vehicle. In cases where a general purpose mobile crane is modified and used as a balloon launch vehicle, the NASA WFF Lifting Devices and Equipment Manager (LDEM) shall review the applicable LECC and any concerns shall

be address by BPO and/or CSBF. The hazard controls identified in HR-26 apply when using a mobile crane as a launch vehicle.

The assigned Danger Area for each of these systems is enclosed within the PLDA defined in section 3.2 and described below:

- For the Balloon Restraining Spool, an area defined by a 30.5 meter (100 ft.) radius centered on the Spool. This area is a buffer area in the event of spool failure or inadvertent release and will only contain essential personnel.
- For the Flight Train, the area is defined as extending from the CSBF parachute cutaway device to the launch spool and to 150 feet on either side of the balloon, up to the launch spool.
- For the balloon launch vehicle is defined by a 96 m (315 ft.) radius circle about the Launch Vehicle (LV) plus a 96 m (315 ft.) radius circle about the Spool / Helium Truck with parallel (leg) lines connecting the outer edges of both circles at their centerlines, and running along either side of the Flight Train (up to 240 m (790 ft.) long).

7.0 VEHICLE / PAYLOAD TRANSMITTERS

A Balloon flight system typically contains Transmitters and Uplink Command Receivers. Balloon Ground Support Equipment (GSE) typically contains the Uplink Command Transmitters.
Below are typical frequency and power ranges of standard balloon vehicle transmitters:

SYSTEM	FREQUENCY RANGE	POWER
L-Band Transmitters (CSBF Telemetry & Science Telemetry)	1435-1525Mhz in 1Mhz or 10Mhz channel allocations	2 Watts
Upper L-Band Transmitter (NTSC Video Telemetry)	1780-1850Mhz in 3Mhz or 10Mhz channel allocations	5 or 10 Watts
S-Band Transmitters (CSBF Telemetry & Science Telemetry)	2200-2400Mhz in 1, 3 or 10Mhz channel allocations	2. 5 or 10 Watts
UHF Transmitters (Payload Command Retransmit)	429.5 & 440.0 MHz 403Mhz to 416Mhz in 5khz channel allocations	1 or 5 Watt
FAA Transponder (FAA)	1090 MHz	150 Watts
**TDRSS (CSBF Telemetry & Science Telemetry)	2287.5 MHz	3.2 Watts
**Iridium (CSBF Telemetry & Science Telemetry)	1616–1626.5 MHz	0.57 Watts
MIP	406.2375, 407.0375, 407.6375, 415.2375, 416.0375, 416.6375 @11Khz	5 Watt

ISM Band	2.4 GHz and 5.8 GHz bands, spread spectrum	< 100mW

**TDRSS is specific to Long Duration Balloon (LDB) flights only. Payload emitters nominally utilize a 3db gain ¼ wave spike or modified J-pole antenna. Iridium is either a low power .57 watt unit (balloon or gondola), or a “Pilot” unit with avg. power of 6 Watts, gain of 8db. TDRSS is always 3.2 watts, but may utilize either a high gain antenna of 17db or a low gain antenna of 6db.

The Maximum*** Personnel Hazard Distances for standard balloon transmitters are:

L-band Transmitter: within 5.75 cm (2.3") of its omni-directional antenna, mounted below the gondola.
Upper L-band Transmitter: within 11.6 cm (4.6") of its omni-directional antenna, mounted below the gondola.
S-band Transmitter: within 10.0 cm (3.9") of its omni-directional antenna, mounted below the gondola.
UHF Transmitter: within 7.5 cm (3") of its omni-directional antenna, mounted below the gondola.
FAA Transponder: within 57 cm (1.9 feet) of its omni-directional antenna, mounted below the gondola.
TDRSS Transmitter, in omni-directional mode: within 5.8 cm (2.3") of its antenna, mounted on top of the gondola.
TDRSS Transmitter, in pointed antenna mode: within 24.5 cm (9.6") of its antenna, mounted on top of the gondola.
Iridium Transmitter: within 2.9 cm (1.1") of its omni-directional antenna, mounted on top of the gondola and balloon.
MIP: within 0.267 m (0.88 ft.) of its antenna, mounted on the gondola.
ISM Band: within 1.83 cm (0.72”) of its antenna, mounted on the apex fitting of a super pressure balloon.

***The personnel hazard distance is maximized when the transmitter is operating at its lowest frequency.

The Maximum**** Ordnance Hazard Distances for standard balloon transmitters are:

L-band Transmitter: within 3 m (10 feet) of its antenna, mounted below the gondola, for 1 Amp/1 Watt/1 Ohm bridgewire-type devices.
Upper L-band Transmitter: within 3 m (10 feet) of its antenna, mounted below the gondola, for 1 Amp/1 Watt/1 Ohm bridgewire-type devices.
S-band Transmitter: within 3 m (10 feet) of its antenna, mounted below the gondola, for 1 Amp/1 Watt/1 Ohm bridgewire-type devices.
UHF Transmitter: within 5.5 m (18 feet) of its antenna, mounted below the gondola, for 1 Amp/1 Watt/1 Ohm bridgewire-type devices.

FAA Transponder: within 11 m (36 feet) of its antenna, mounted below the gondola, for 1 Amp/1 Watt/1 Ohm bridgewire-type devices.
TDRSS Transmitter, in omni-directional mode: within 3 m (10 feet) of its antenna, mounted on top of the gondola, for 1 Amp/1 Watt/1 Ohm bridgewire-type devices.
TDRSS Transmitter, in pointed antenna mode: within 5.4 m (18 feet) of its antenna, mounted on top of the gondola, for 1 Amp/1 Watt/1 Ohm bridgewire-type devices.
Iridium Transmitter: within 3 m (10 feet) of its antenna, mounted on top of the gondola and balloon, for 1 Amp/1 Watt/1 Ohm bridgewire-type devices.
MIP: within 6.8 m (22 ft.) of its antenna, mounted on the gondola, for 1 Amp/1Watt/1Ohm bridgewire-type devices.
ISM Band: within 3 m (10 feet) of its antenna, mounted on the apex fitting of a super pressure balloon, for 1 Amp/1 Watt/1 Ohm bridgewire-type devices.

****The ordnance hazard distance is maximized when the transmitter is operating at its lowest frequency.

Danger Area calculations for RF emitters are documented in the Safety Engineering Notes contained in Enclosure 3.

Listed below are the typical frequency and power ranges for standard balloon GSE and/or Uplink Command Transmitters:

Ground Telemetry (Permanent or Mobile) Stations:	Frequency (MHz)	Power (Watts)	Antenna Gain (dB)
UHF: Payload/Vehicle Command & Control	429.5, 440.0	100	Omni (3 dB), or Directional @ 14 dB
VHF: CSBF & Science Voice Communications	138-142Mhz in 5Khz channel allocations	100	Omni (3 dB)
VHF: CSBF Collar Command	138.54	100	Omni (3 dB)
Iridium: CSBF TM, Science TM, Payload Command & Control	1616 – 1626.5	0.57	Omni (3 dB)
VHF: Airfield Operations, Unicom Frequency	108 - 137	2	Omni (3 dB)
Transportable Transmitters:			
UHF “Bitty Box”: Payload/Vehicle Command & Control	429.5, 440.0	5	Omni (3 dB)
VHF DTMF Handie-Talkie: CSBF Collar Command	138.54	5	Omni (3 dB)
VHF: CSBF & Science Voice Communications	138-142Mhz in 5Khz channel allocations	5	Omni (3 dB)
Aircraft Station Transmitters:			

VHF: CSBF & Science Voice Communications	138-142Mhz in 5Khz channel allocations	100	Omni (3 dB)
VHF: CSBF Collar Command	138.54	100	Omni (3 dB)
Iridium: CSBF TM, Science TM, Payload Command & Control	1616 – 1626.5	0.57	Omni (3 dB)
VHF: Airfield Operations, Unicom Frequency	108 - 137	2	Omni (3 dB)

At **Ft. Sumner, New Mexico**, all emitters are located on the roof of the 3-story Tower Building.
At **Palestine, Texas**, all emitters are located on the roof of the 4-story Staging Building.
At **Esrange, Sweden**, all emitters are located either on the 'cathedral' building roof, or on the unmanned Keops mountain transmit site, several kilometers distant.
At **Alice Springs, Australia**, all emitters are located on the roof of the Tower Building.
At **Willy Field, Antarctica**, all emitters are located on the roof of the TM Building.
At **New Zealand**, all emitters are located on a platform next to the hangar.
At **all locations**, the Transportable transmitters (Handie-Talkie, Bitty Box, etc) can be located anywhere on the launch field.

The Maximum Personnel Hazard Distances for the Transportable Transmitters are as follows:

UHF "Bitty Box" Payload/Vehicle Command & Control Transportable Transmitter: within <u>16.67 cm (6.6")</u> of its antenna.

VHF DTMF Handie-Talkie CSBF Collar Command Transportable Transmitter: within <u>28.35 cm (11.2")</u> of its antenna.

VHF CSBF & Science Voice Communications Transportable Transmitter: within <u>29.41 cm (11.6")</u> of its antenna.

The Maximum Ordnance Hazard Distances for the Transportable Transmitters are as follows:

UHF "Bitty Box" Payload/Vehicle Command & Control Transportable Transmitter Ground Station: within <u>102 meters (335 feet)</u> of its antenna for 1 Amp/1 Watt/1 Ohm bridgewire-type devices.

VHF DTMF Handie-Talkie CSBF Collar Command Transportable Transmitter: within <u>16 meters (52 feet)</u> of its antenna for 1 Amp/1 Watt/1 Ohm bridgewire-type devices.

VHF CSBF & Science Voice Communications Transportable Transmitter: within <u>90 meters (294 feet)</u> of its antenna for 1 Amp/1 Watt/1 Ohm bridgewire-type devices.

Transmitters in balloon payloads will be addressed in mission-specific payload GSP / GSDP.

8.0 RADIOACTIVE MATERIALS

Not Applicable – none contained in the Balloon launch vehicle system. Radioactive materials in payloads will be addressed in mission-specific payload GSP / GSDP.

9.0 OTHER HAZARDOUS SYSTEMS/MATERIALS/PROCEDURES

Not Applicable – none contained in the Balloon launch vehicle system. Hazardous systems/materials in payloads will be addressed in mission-specific payload GSP / GSDP.

10.0 BTS CERTIFICATION

The BTS is checked out and certified for launch by CSBF personnel. GSA reviews the procedure from a Ground Safety (crew ops) perspective. Reliability for FTS is a flight safety function. Additional information concerning the BTS is covered in a separate document, Balloon Flight Termination System Report, 820-FTSR-2011-1. Preparations for the BTS are as follows.

CSBF performs an annual environmental system checkout to verify that the system will perform under the varied environmental flight conditions. All units are tested prior to shipment to the field. The system is first calibrated and verified to be in a mission readiness state. Technicians test all functions of the system and verify the system is operational within specifications. The environmental checkout then tests all aspects of the system, from command receiver sensitivity to verification of sufficient safety margin in the capacitive discharge system to fire the ordnance that terminates the flight, at the hot and cold extremes of the testing. The environmental check out is an 8 hour test consisting of 4 hours at the cold extreme of -55 C and 4 hours at the hot extreme of +50 C. The system is also exposed to altitude variations during the hot/cold testing of the test, simulating float conditions, as well as ascent/descent conditions. The system is closely monitored during this testing for any anomalies.

Upon successful testing of the system in the environmental chamber, documentation is reviewed and filed. The system is then labeled as to its fitness for mission critical operations. The units are then stored until needed for flight operations.

In the field, the units are installed in the associated flight hardware, parachutes and flight train, to meet mission objectives. They undergo further field testing, as to operational and functional status, with system testing through all possible flight and ground interfaces (Line of sight tower/portable/aircraft, over the horizon TDRSS/iridium, etc.). The units are then declared flight ready. During pre-launch/launch checkouts, the units are again tested to verify operational and functional status with tower command systems, portable command systems, and aircraft command systems, as well as any line of sight and over the horizon command uplink and telemetry downlinks.

Units are then flown and recovered. Upon recovery of the units, they are then recalibrated and brought back up to an operational status. Part of the recalibration process is full physical inspection of all components and wiring harnesses that may have sustained damage during flight operations. If any damage is evident to physical hardware or the unit exhibits anomalies during the checkout procedure, further refurbishment may be required. Any repair of an active component in the unit, will negate the yearly environmental, requiring the unit to repeat environmental testing to flight qualify the repair. The unit is deemed environmentally and flight qualified for 1 year from the date of the last full environmental test, upon which they will again go through extensive environmental testing, regardless of flight status.

11.0 HAZARDOUS CIRCUITS APPROVAL

The following EED circuits have been previously reviewed by Wallops Flight Facility (WFF) Safety Office personnel and it has been determined that the EED circuit requirements as stated in RSM-2002C, WFF Range Safety Manual, are satisfied:

1. Collar Release System Firing Circuit
2. Balloon Termination System – Remote Firing Unit (RFU) Circuit
3. Balloon Termination System –RFU Capacitor Circuit
4. Balloon Termination System – Universal Terminate Package (UTP) Relays-Arm/Fire-Aneroid Switch Circuit
5. Balloon Termination System –UTP Command System Circuit
6. Parachute Release System – Capacitor Board Circuit
7. Parachute Release System – Semi-Automatic Firing Circuit
8. Gondola Automatic Parachute Release System Logic Circuit
9. Gondola Automatic Parachute Release Aneroid Circuit
10. MIP mRFU Terminate PCB & Tow Balloon Separate
11. MIP Command System
12. MIP Burst Detect/Aneroid Circuitry
13. MIP Aneroids
14. MIP mSAPR

12.0 HAZARDOUS PROCEDURES APPROVAL

NASA BPO assembly and test procedures will be reviewed and listed in the mission specific GSP / GSDP. These procedures will comply with the criteria of RSM-2002C, WFF Range Safety Manual. The guidelines listed below are all-inclusive of NASA/WFF launch vehicles.

<u>NASA/WFF Policy Guidelines</u>

800-PG-8710.0.2C	Operations in Cold Weather Environments
NPR 1800.1C	NASA Occupational Health Program Procedures (Section 2.15)
800-PG-1700.1.1	Wallops Flight Facility Personal Protective Equipment Program
800-PG-8715.5.1	Range Safety Process for Programs and Projects

13.0 WAIVERS or EQUIVALENT LEVEL of SAFETIES

None.

14.0 SAFETY ENGINEERING NOTES

The following Safety Engineering Notes are provided in Enclosure 3:

(1) Balloon Prelaunch and Launch Danger Areas Calculations
(2) Hazards of Electromagnetic Radiation to Ordnance (HERO) Distance Calculations
(3) Hazards of Electromagnetic Radiation to Personnel (HERP) Distance Calculations
(4) Pressure Vessel Danger Area Calculations

15.0 HAZARD ANALYSIS REPORTS

Risk analyses were performed on the hazards identified for the Balloon launch vehicle systems. Payload risks will be reviewed in GSP for each specific flight. The risk analyses were performed in accordance with 800-PG-8715.5.1; this document describes the method of combining within a matrix the hazard severity and the hazardous event probability to obtain a Risk Assessment Code (RAC) output. Balloon recovery risks are usually not significant; however, personnel performing recovery shall have relevant training and be Ordnance Certified. Hazards analysis worksheets used to develop this analysis are provided in Enclosure 4.

TABLE 15.1 Summary of Risk Assessment Codes

HAZARD NUMBER	HAZARD	PROBABILITY	SEVERITY	RAC
HR-1	Personnel Injured by Falling Debris	E	I	3
HR-2	High Pressure Gas Fitting/Equipment Failure	E	I	3
HR-3	Premature/Inadvertent Payload Release	E	I	3

HR-4	Premature/Inadvertent Balloon Release	E	I	3
HR-5	Mechanical Failure of Flight Train	E	I	3
HR-6	Premature/Inadvertent EED Event	E	I	3
HR-7	Spool Released into Crew Member	E	I	3
HR-8	Balloon Burst During Inflation	E	I	3
HR-9	Spool Vehicle Hits Crew Member During Inflation	D	II	3
HR-10	Balloon Shucker injured by Balloon Motion	E	I	3
HR-11	Loss of Balloon Control due to Strong Winds	E	I	3
HR-12	Loss of Balloon due to Strong Winds	E	I	3
HR-14	Insufficient Lift in Balloon System	E	I	3
HR-15	Universal Terminate Package (UTP) Damaged During Launch	E	I	3
HR-16	Flight Train Wiring Damaged due to Impact or Scraping on the Ground	E	I	3
HR-18	Crew Member Fall Off Launch Vehicle (LV)	E	I	3
HR-19	Flight Train Becomes Entangled in the LV	E	I	3
HR-20	Flight Train or Payload Impacts Launch Vehicle	E	II	3
HR-21	Payload Launch Head Release Mechanism Fails	E	I	3
HR-22	Balloon Payload Strikes Ground and is Damaged due to Late Release	D	II	3
HR-23	Launch Vehicle (LV) Breakdown (including stuck on pad)	E	II	3
HR-24	Personnel/Equipment Run Over by LV During or After Launch	E	I	3
HR-25	Catastrophic Balloon Failure after Spool Release/Before Payload Release	E	I	3
HR-26	Personnel Injured by Falling Boom on Commercial Launch Crane	D	II	3

RAC 1 Operation Prohibited: Risk must be reduced to a RAC 2 or RAC 3
RAC 2 Waiver Required for Operation

RAC 3 Operations Permissible

ENCLOSURES

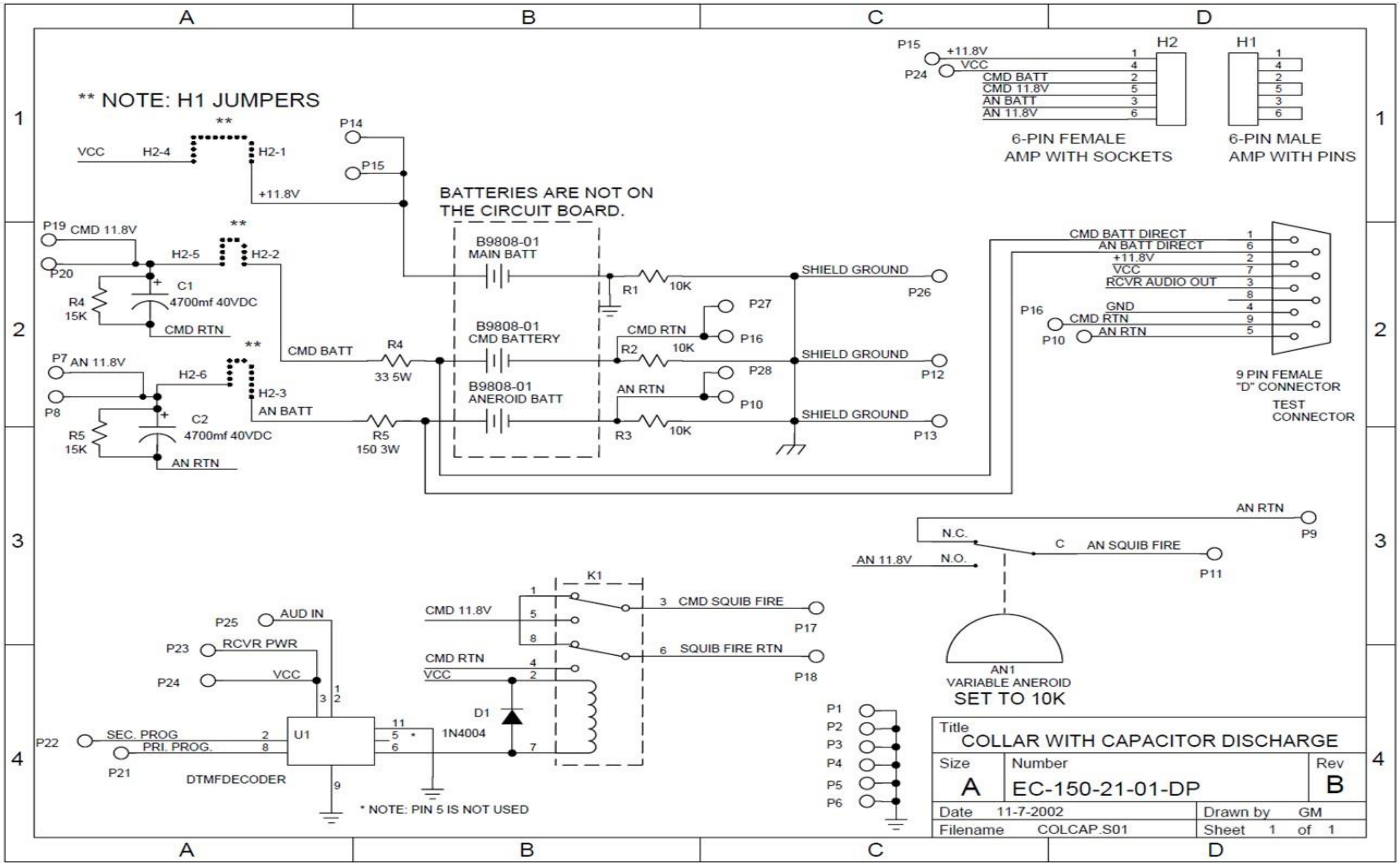
ENCLOSURE 1 CHARACTERISTICS OF LAUNCH VEHICLE (ELECTRO-EXPLOSIVE DEVICES)

DEVICE	QTY	FUNCTION	RESISTANCE	MAX NO-FIRE	ALL-FIRE
Guillotine: PSEMC 6801	2	Collar Release	Bridge-wire: 1.02 ±0.10 Ω (-1) 1.00 ±0.10 Ω (-2, -3) Pin-to-Case: 2 MΩ @ 500 VDC	1 Amp, 1Watt for 5 minutes	4.5 Amps
Guillotine: PSEMC 6803	2	Balloon Flight Termination & Balloon/Parachute Separation	Bridge-wire: 1.02 ±0.10 Ω (-1) 1.00 ±0.10 Ω (-2, -3) Pin-to-Case: 2 MΩ @ 500 VDC	1 Amp, 1Watt for 5 minutes	4.5 Amps
Balloon Destruct Line Guillotine: Tech Ordnance 210227 30 lb. Pull (+/- 20 lb.)	1	Severs Balloon Destruct Line from top of Parachute	N/A	N/A	N/A
Rip Stitch Guillotine: Tech Ordnance 210227 30 lb. Pull (+/- 20 lb.)	1	Severs rip stitch nylon cord Line from top of Parachute (Rip Stitch is only provided for suspended weights above 4000lbs.)	N/A	N/A	N/A
Guillotine: PSI 6802	2	Parachute Separation From Payload following impact	Bridge-wire: 1.02 ±0.10 Ω (-1) 1.00 ±0.10 Ω (-2, -3) Pin-to-Case: 2 MΩ @ 500 VDC	1 Amp, 1 Watt for 5 minutes	4.5 Amps
Guillotine: PSI 6802	2	Tow Balloon Separation from main balloon (if tow balloon is needed)	Bridge-wire: 1.02 ±0.10 Ω (-1) 1.00 ±0.10 Ω (-2, -3) Pin-to-Case: 2 MΩ @ 500 VDC	1 Amp, 1 Watt for 5 minutes	4.5 Amps

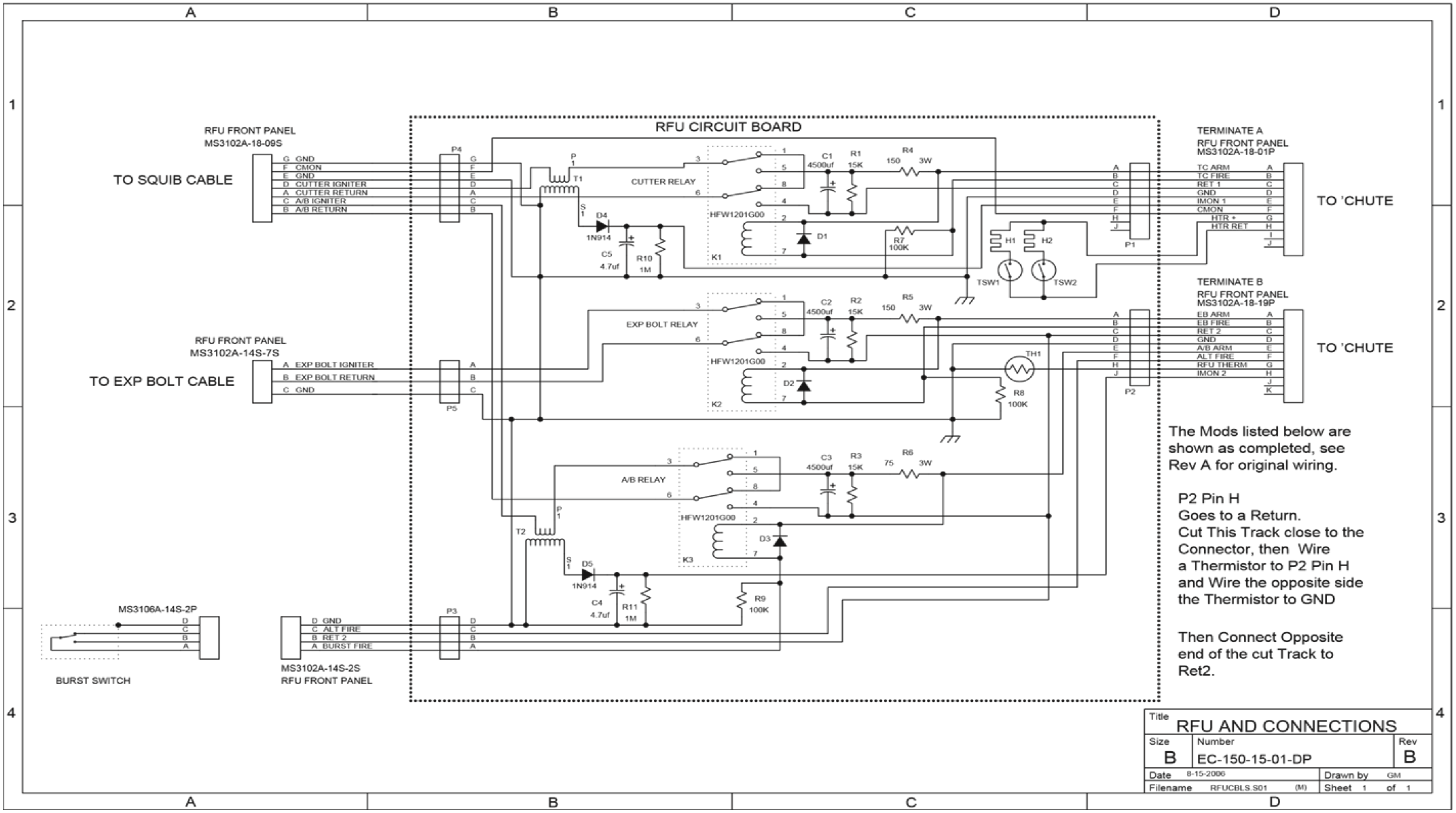
ENCLOSURE 2 BALLOON SYSTEM SCHEMATICS

The following schematics are included as part of this enclosure:

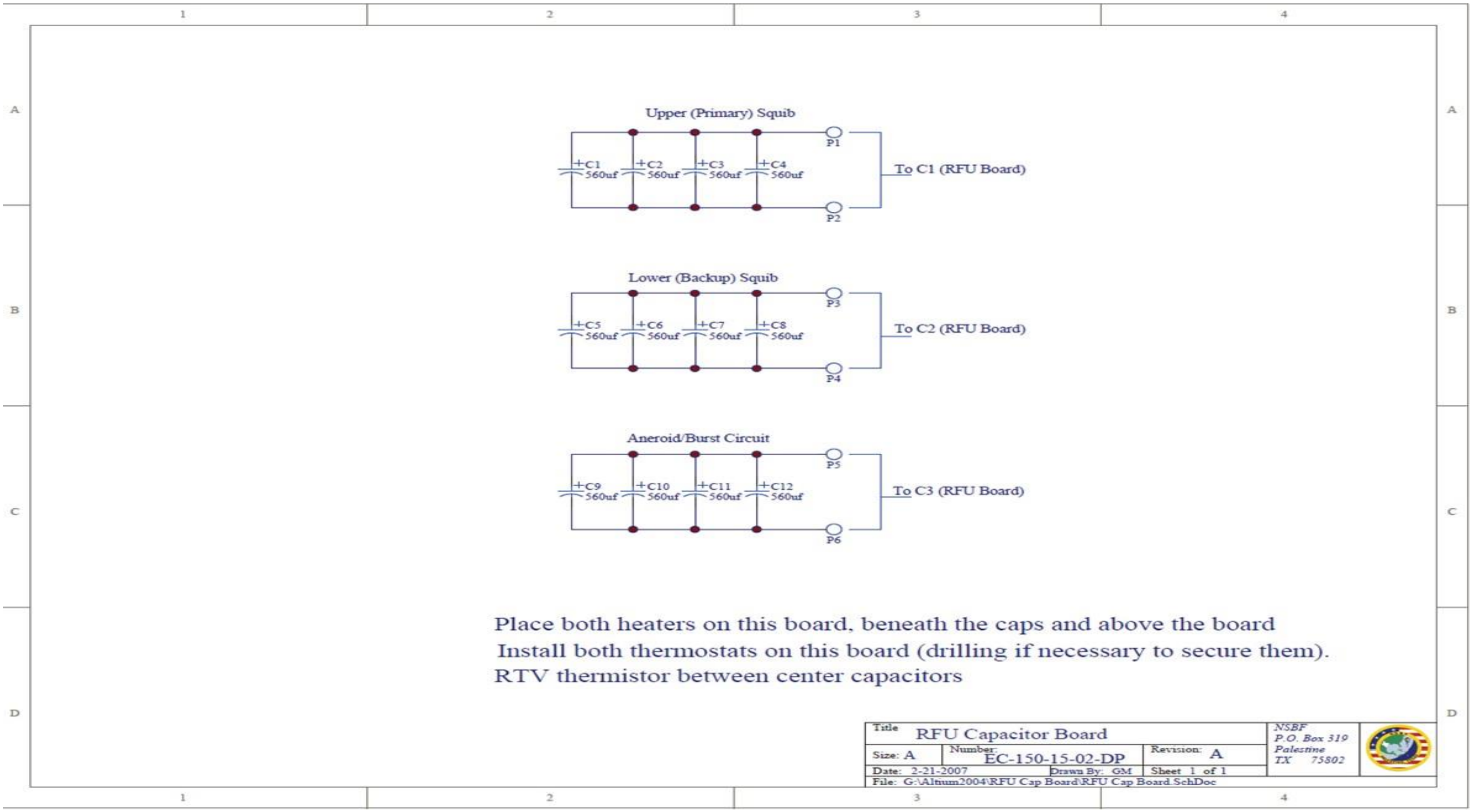
1. Collar Release System Firing Circuit
2. Balloon Termination System – Remote Firing Unit (RFU) Circuit
3. Balloon Termination System –RFU Capacitor Circuit
4. Balloon Termination System – Universal Terminate Package (UTP) Relays-Arm/Fire-Aneroid Switch Circuit
5. Balloon Termination System –UTP Command System Circuit
6. Parachute Release System – Capacitor Board Circuit
7. Parachute Release System – Semi-Automatic Firing Circuit
8. Gondola Automatic Parachute Release System Logic Circuit
9. Gondola Automatic Parachute Release Aneroid Circuit
10. MIP mRFU Terminate PCB & Tow Balloon Separate
11. MIP Command System
12. MIP Burst Detect/Aneroid Circuitry
13. MIP Aneroids
14. MIP mSAPR



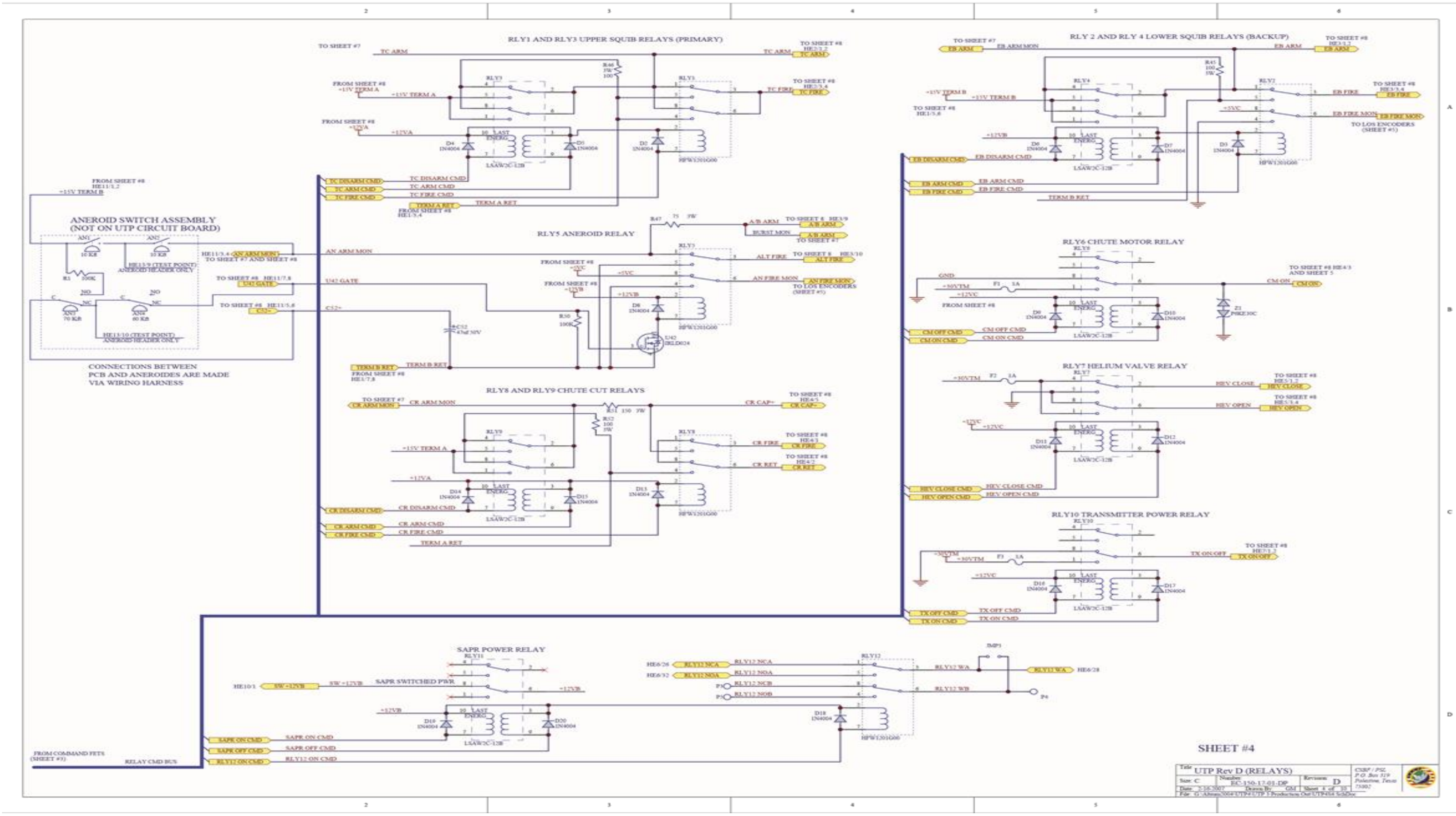
Enclosure 2-1 Collar Release System Firing Circuit Schematic



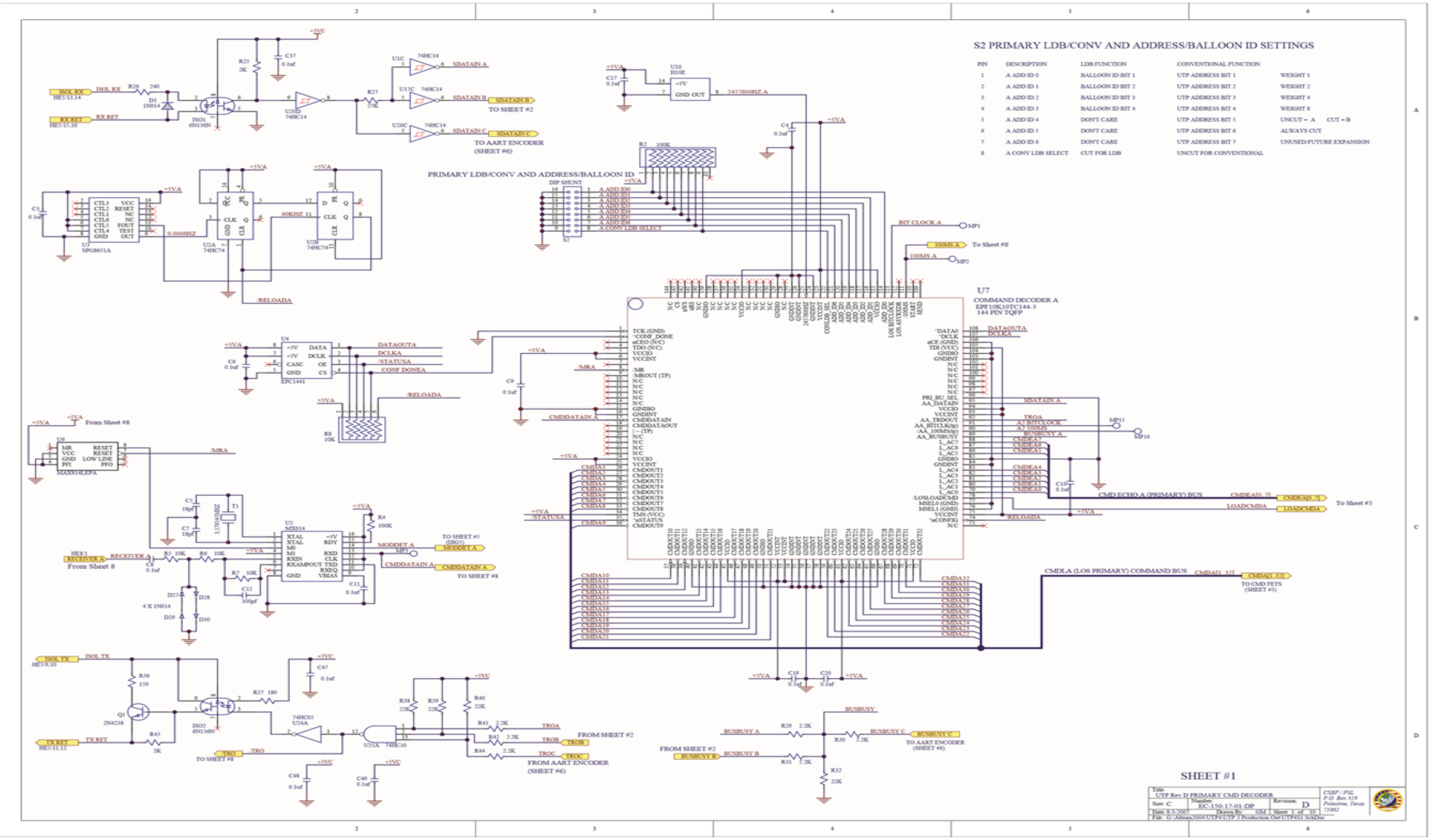
Enclosure 2-2 Balloon Termination System – Remote Firing Unit Circuit Schematic



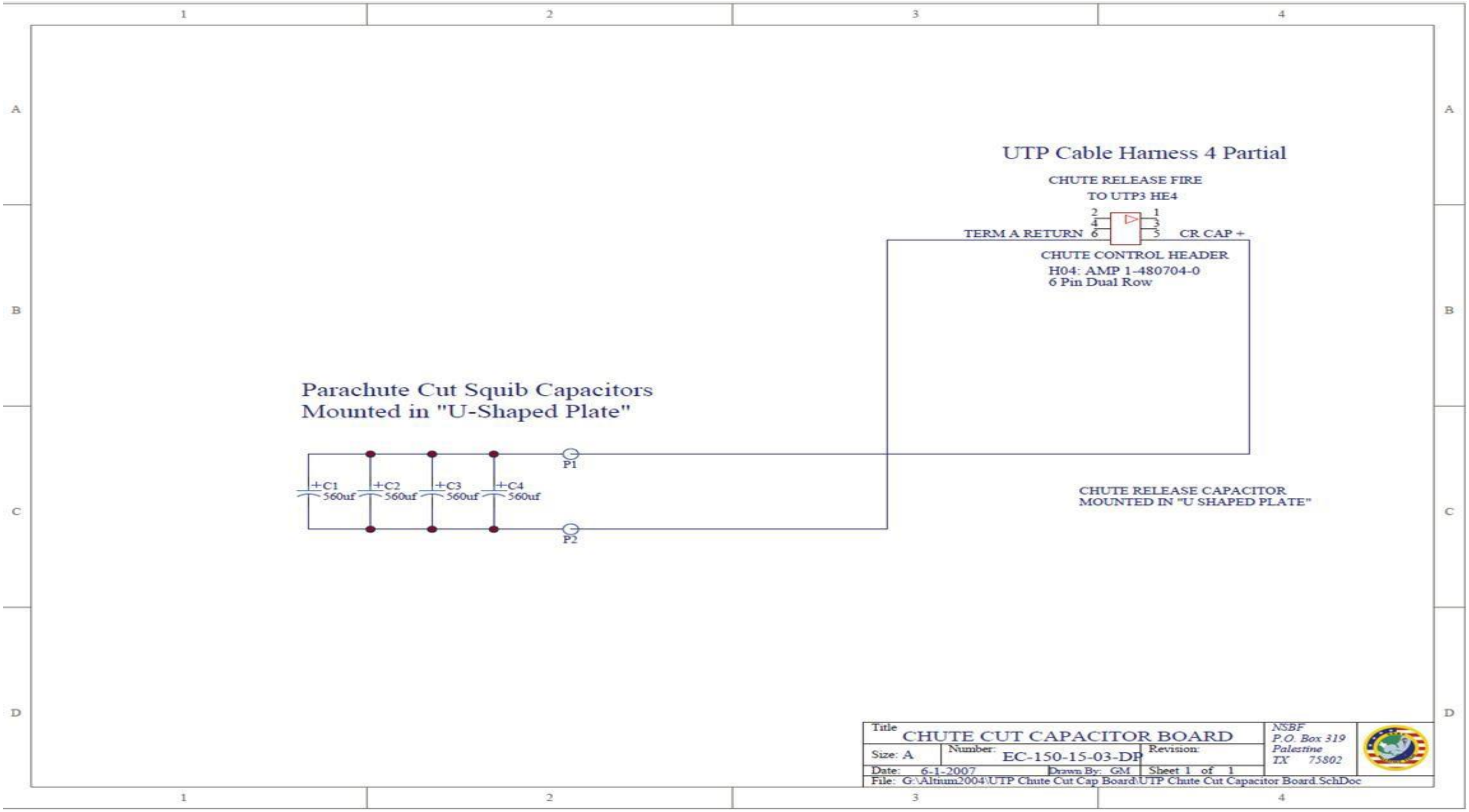
Enclosure 2-3 Balloon Termination System – Remote Firing Unit Capacitor Firing Circuit Schematic



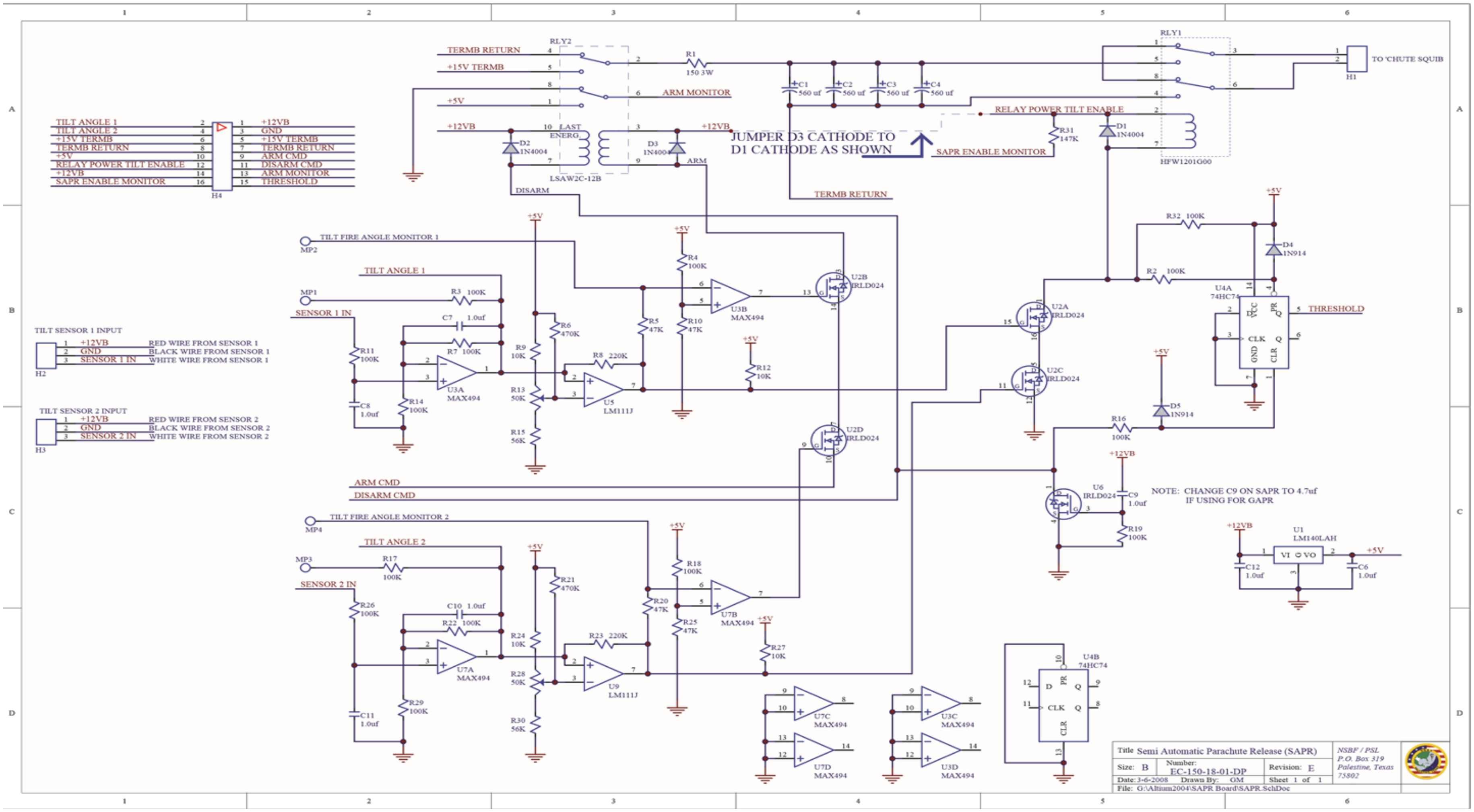
Enclosure 2-4 Balloon Termination System – Universal Terminate Package Relays-Arm/Fire-Aneroid Switch Circuit Schematic



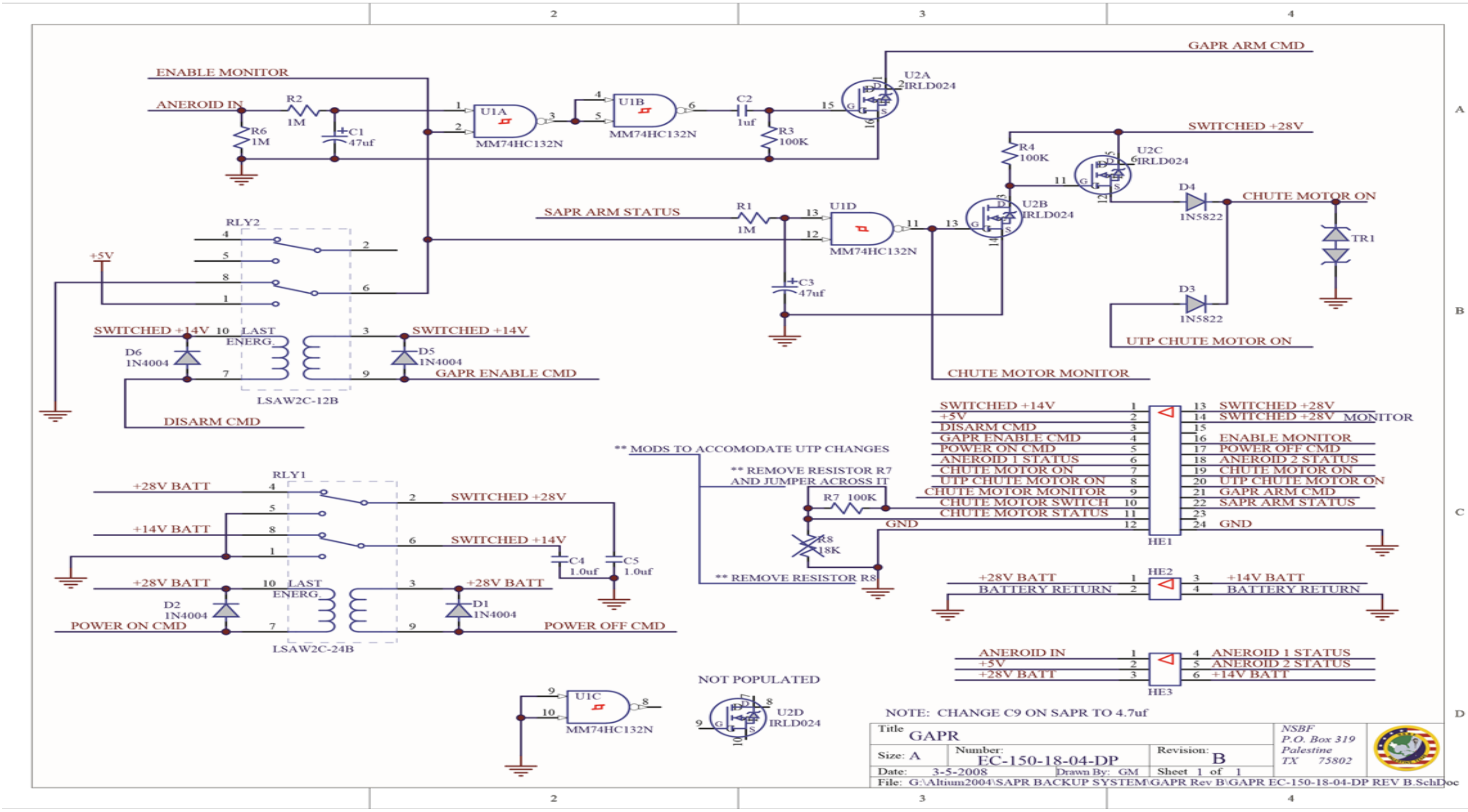
Enclosure 2-5 Balloon Termination System – Universal Terminate Package Command System Circuit Schematic



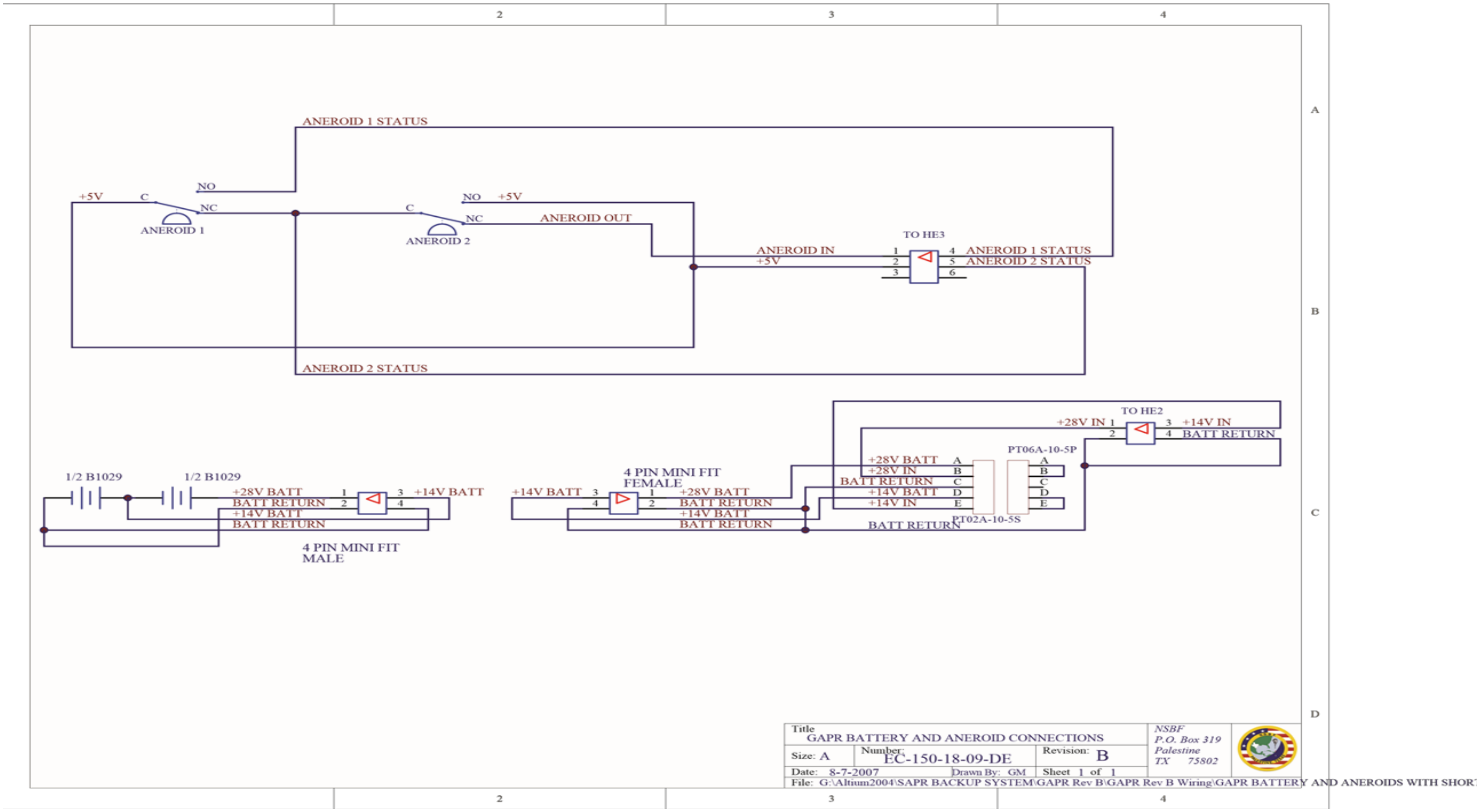
Enclosure 2-6 Parachute Release System – Capacitor Board Circuit Schematic



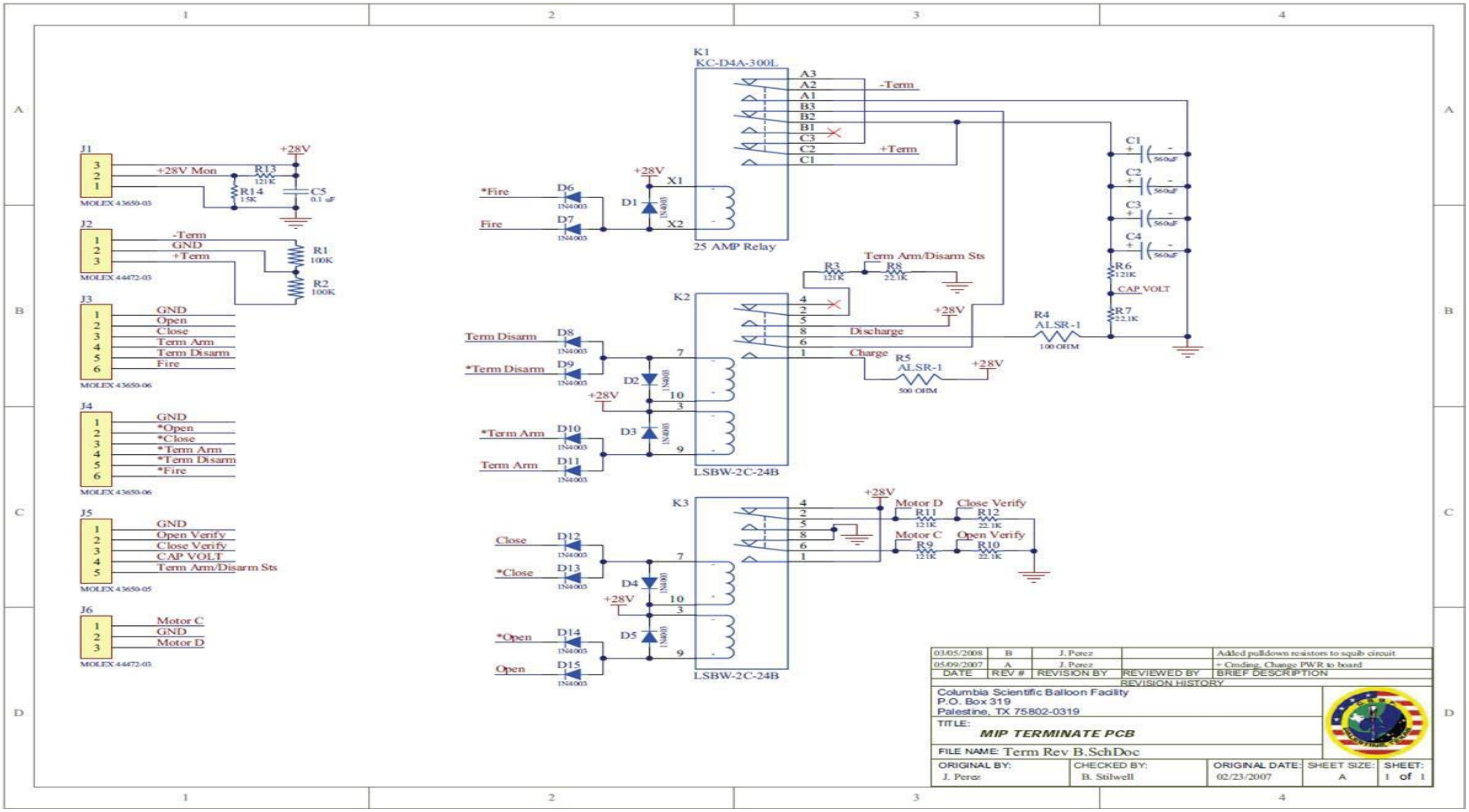
Enclosure 2-7 Parachute Release System – Semi-Automatic Firing Circuit Schematic



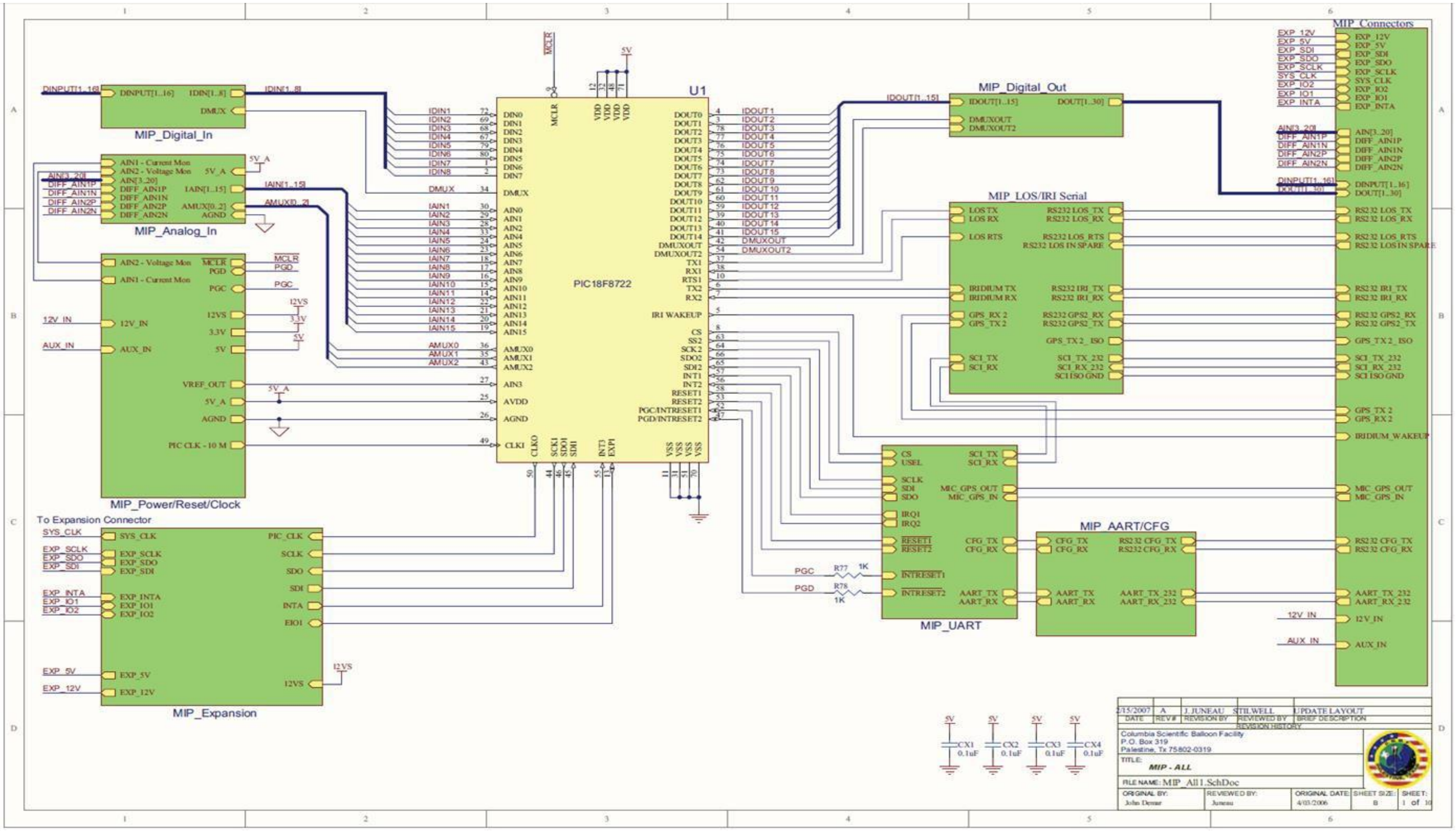
Enclosure 2-8 Gondola Automatic Parachute Release System Logic Circuit Schematic



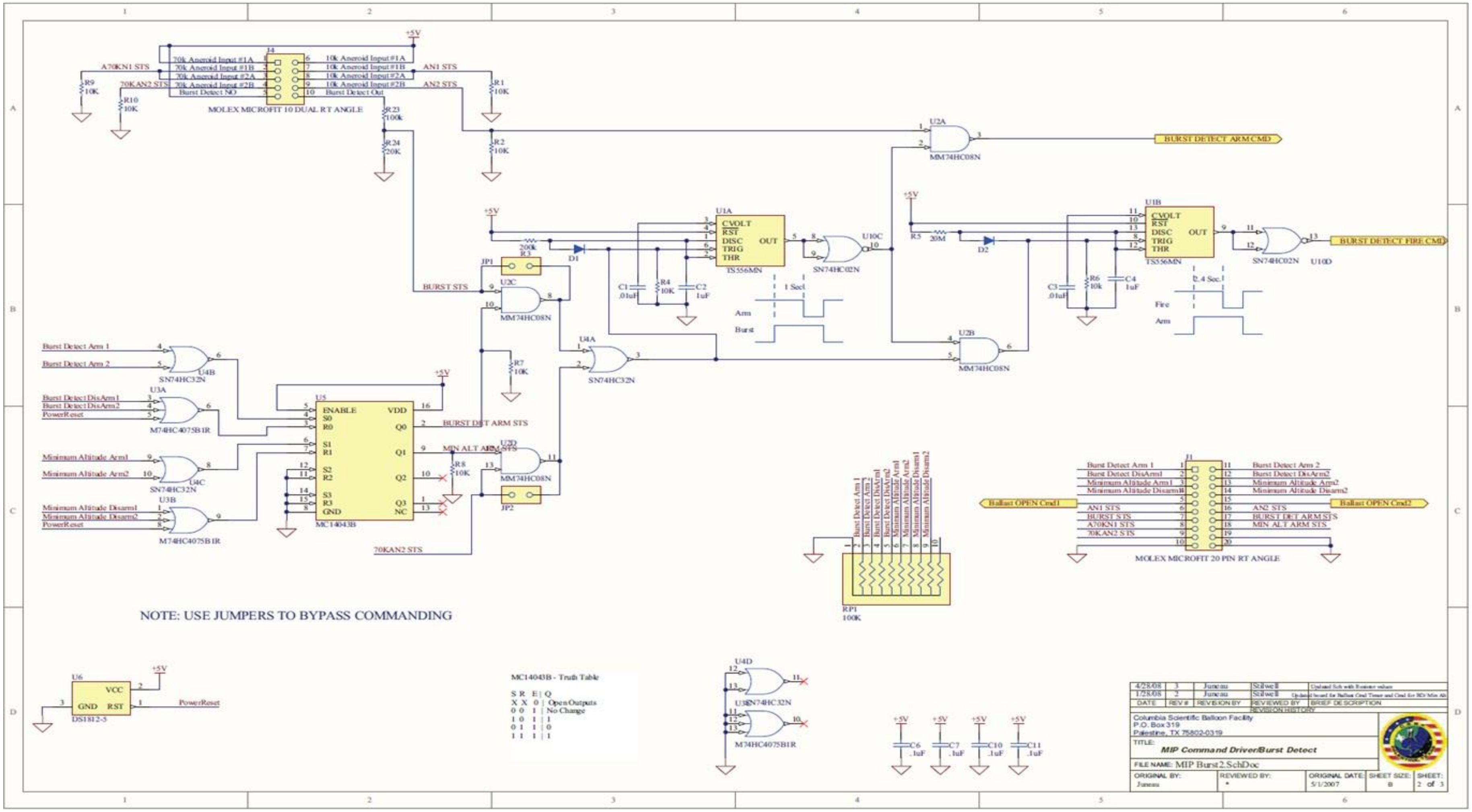
Enclosure 2-9 Gondola Automatic Parachute Release Aneroid Schematic



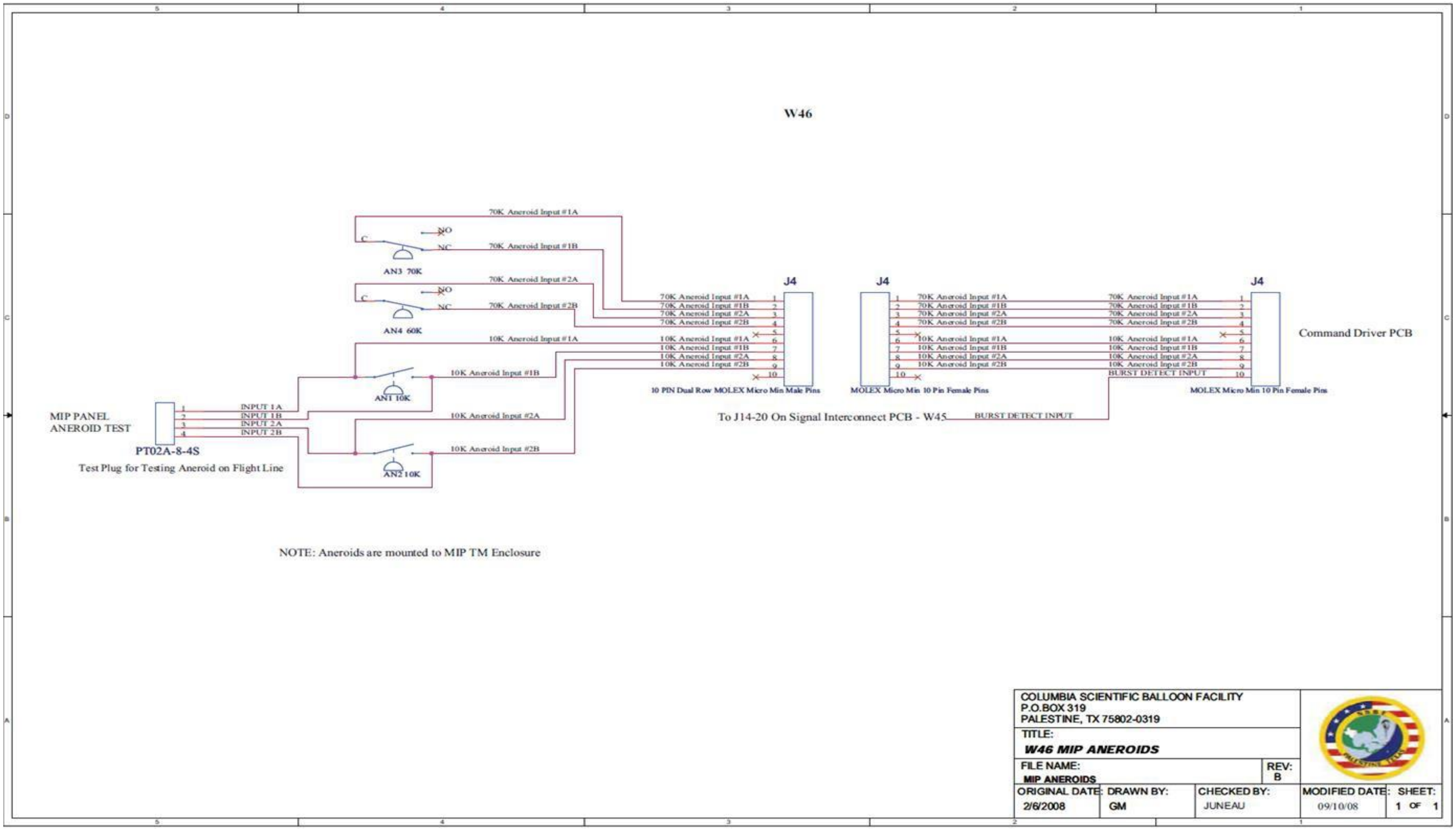
Enclosure 2-10 MIP mRFU Terminate PCB & Tow Balloon Separate Circuit Schematic



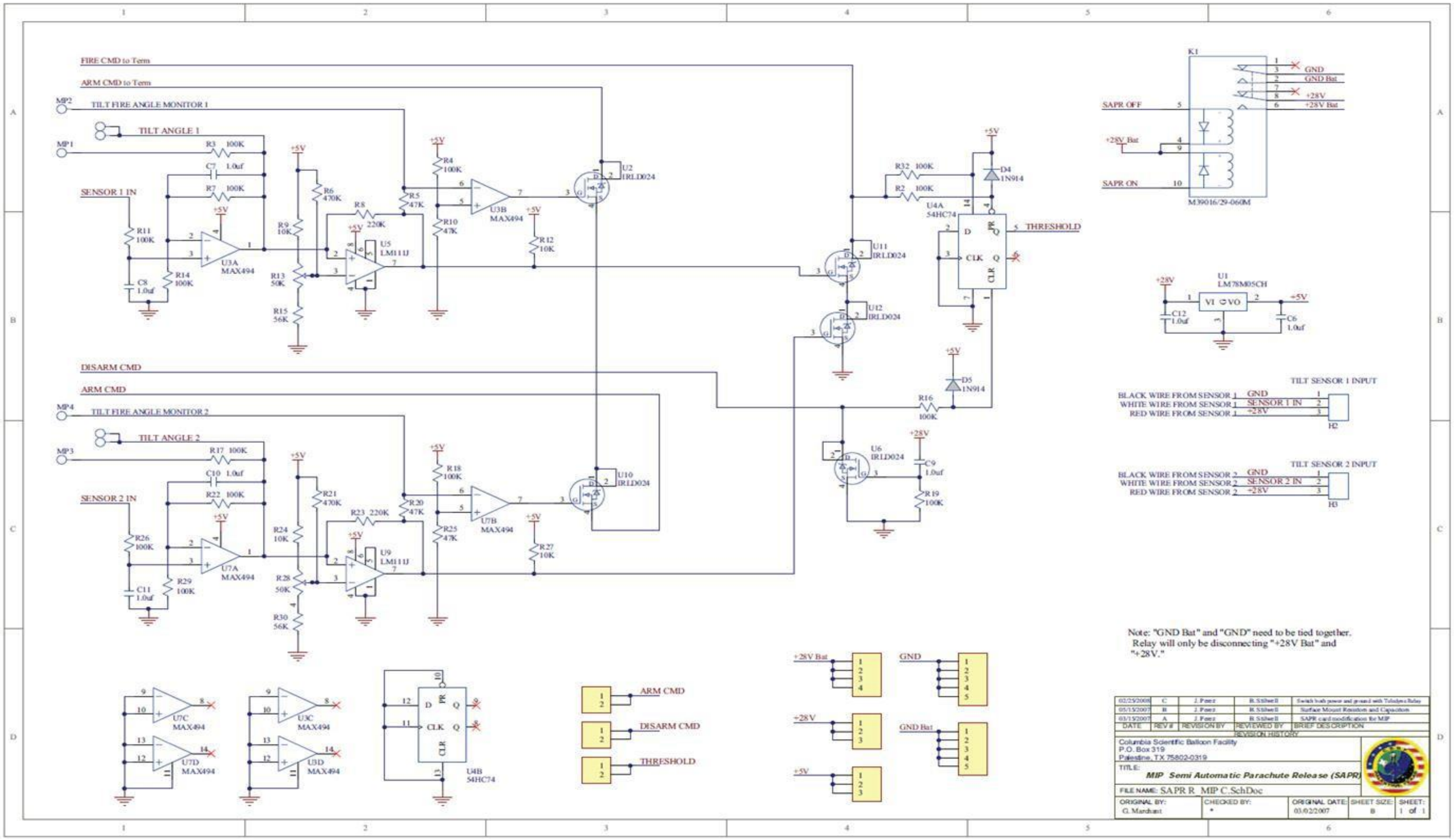
Enclosure 2-11 MIP Command System Circuit Schematic



Enclosure 2-12 MIP Burst Detect/Aneroid Circuit Schematic



Enclosure 2-13 MIP Aneroid Circuit Schematic



Enclosure 2-14 MIP mSAPR Circuit Schematic

ENCLOSURE 3 SAFETY ENGINEERING NOTES
Balloon

1. Balloon Pre Launch and Launch Danger Area calculations:

The **PLDA** for assembled Balloon launch vehicles is defined by 315-ft radius about the Launch Vehicle (LV), and a 315-ft radius about the Spool / Helium Truck, with parallel lines along the Flight Train connecting the outer edges of the two circles.

The **LDA** for balloons launch vehicles is defined as a 500 ft. buffer around the LLA.

2. Hazards of Electromagnetic Radiation to Personnel (HERP) distance calculations:

To calculate the distance at which personnel can be safely exposed to electromagnetic radiation we use the following equation: $\mathbf{d = [P_A G / (4\pi P_d)]^{1/2}}$

Where d = the distance being calculated in centimeters
P_A = the average power of the transmitter in watts
G = the antenna gain measured in decibels = 1 for omni-directional antennas
P_d = the maximum allowable power density based upon frequency as follows:

Frequency (MHz)	Power Density (mW/cm^2)
100 – 300	1
300 – 3,000	Frequency/300
3,000 – 15,000	10
15,000 – 300,000	10

In certain cases, it will be necessary to calculate the Average Power from the Peak Power using the following equation: $\mathbf{P_A = P_{PEAK} \times PW \times PRF}$

Where P_A = the average power of the transmitter in watts
P_{PEAK} = the peak power of the transmitter in watts
PW = the pulse width
PRF = the pulse repetition frequency

(a) <u>L-Band Telemetry Transmitters HERP</u>

$d = [P_A G / (4\pi P_d)]^{1/2} = [(2 \text{ Watts} \times 1)(1000 \text{ mW/Watt})/(4\pi(1444.5/300) \text{ mW/cm}^2)]^{1/2}$
d = **<u>5.75 centimeters</u>**

(b) <u>Upper L-Band Radar Transmitters HERP</u>

$d = [P_A G / (4\pi P_d)]^{1/2} = [(10.0 \text{ Watts} \times 1)(1000 \text{ mW/Watt})/(4\pi(1786/300 \text{ mW/cm}^2))]^{1/2}$

d = **11.56 centimeters**

(c) S-Band Transmitter HERP

$d = [P_AG / (4\pi P_d)]^{1/2} = [(10 \text{ Watts} \times 1)(1000 \text{ mW/Watt})/(4\pi(2365.5/300 \text{ mW/cm}^2))]^{1/2}$
d = **10.05 centimeters**

(d) UHF Transmitter HERP on the vehicle

$d = [P_AG / (4\pi P_d)]^{1/2} = [(1 \text{ Watt} \times 1)(1000 \text{ mW/Watt})/(4\pi(429.5/300 \text{ mW/cm}^2))]^{1/2}$
d = **7.46 centimeters**

UHF Transmitter HERP on the ground station

$d = [P_AG / (4\pi P_d)]^{1/2} = [(100 \text{ Watt} \times 1)(1000 \text{ mW/Watt})/(4\pi(429.5/30 \text{ mW/cm}^2))]^{1/2}$
d = **377 centimeters**

(e) FAA Transponder HERP

$d = [P_AG / (4\pi P_d)]^{1/2} = [(150 \text{ Watts} \times 1)(1000 \text{ mW/Watt})/(4\pi(1090/300 \text{ mW/cm}^2))]^{1/2}$
d = **57.32 centimeters**

(f) TDRSS Transmitter HERP, Omni-directional Antenna

$d = [P_AG / (4\pi P_d)]^{1/2} = [(3.2 \text{ Watts} \times 1)(1000 \text{ mW/Watt})/(4\pi(2287.5/300 \text{ mW/cm}^2))]^{1/2}$
d = **5.78 centimeters**

(g) TDRSS Transmitter HERP, Pointed Antenna

$d = [P_AG / (4\pi P_d)]^{1/2} = [(3.2 \text{ Watts} \times 18)(1000 \text{ mW/Watt})/(4\pi(2287.5/300 \text{ mW/cm}^2))]^{1/2}$
d = **24.52 centimeters**

(h) Iridium Transmitter HERP

$d = [P_AG / (4\pi P_d)]^{1/2} = [(0.57 \text{ Watts} \times 1)(1000 \text{ mW/Watt})/(4\pi(1616/300 \text{ mW/cm}^2))]^{1/2}$
d = **2.89 centimeters**

(i) UHF “Bitty Box” HERP

$d = [P_AG / (4\pi P_d)]^{1/2} = [(5.0 \text{ Watts} \times 1)(1000 \text{ mW/Watt})/(4\pi(429.5/300 \text{ mW/cm}^2))]^{1/2}$
d = **16.67 centimeters**

(j) VHF DTMF Handie Talkie HERP

$d = [P_A G / (4\pi P_d)]^{1/2} = [(5.0 \text{ Watts} \times 1)(1000 \text{ mW/Watt})/(4\pi(138.54/300 \text{ mW/cm}^2))]^{1/2}$
d = **28.35 centimeters**

(k) VHF CSBF Science & Voice Communications

$d = [P_A G / (4\pi P_d)]^{1/2} = [(5.0 \text{ Watts} \times 1)(1000 \text{ mW/Watt})/(4\pi(138.0/300 \text{ mW/cm}^2))]^{1/2}$
d = **29.41 centimeters**

(l) MIP CSBF payload transmitter

$d = [P_A G / (4\pi P_d)]^{1/2} = [(5.0 \text{ Watts} \times 3)(1000 \text{ mW/Watt})/(4\pi(406.2/300 \text{ mW/cm}^2))]^{1/2}$
d = **29.69 centimeters**

(m) ISM Band transmitter

$d = [P_A G / (4\pi P_d)]^{1/2} = [(0.1 \text{ Watts} \times 3)(1000 \text{ mW/Watt})/(4\pi(2400/30) \text{ mW/cm}^2)]^{1/2}$
d = **0.06 ft.**

3. Hazards of Electromagnetic Radiation to Ordnance (HERO) distance calculations:

To calculate the distance at which ordnance can be safely exposed to electromagnetic radiation we use the DOD Approved calculator from OP 3565. When using the HERO Safe Separation Distance Calculator to determine a safe separation distance, it is the average power of a transmitter, the antenna gain in dBi, and the lowest operational frequency of the transmitter that are used to calculate the safe separation distances. In the past, HERO Safe Separation Distance defaulted to no less than 10 feet for many of the larger emitter systems, as well as for most portable, mobile, and handheld systems. This result was generally adequate as there was no real need to get closer than 10 feet to an ordnance item.

However, there are a number of exceptions whereby sources of radio-frequency (RF) emissions (some of which are unintended and some of which are low-power devices) are expected to be, or are required to be, closer than 10 feet to ordnance or used in storage, assembly, and build-up areas. These devices are generally very low output devices (i.e., less than 1 watt) and their proximity to ordnance and low output power require different techniques for mitigating HERO. In fact, with very low output devices the result is often the relaxation of the 10-foot rule. The table below provides exceptions to the minimum safe separation distance requirement of 3 meters (10 feet) and is particularly useful for handheld devices radiating at less than 1 watt in and around areas that have HERO UNSAFE or HERO UNRELIABLE and HERO SUSCEPTIBLE

ORDNANCE. These exceptions are built into the HERO Safe Separation Distance Calculator.

The calculator is designed utilizing the far field equation. Near field can be calculated using the far field equation and a near field gain reduction factor. However, we will use the calculator as is; this will provide a larger safety factor when computing in the near field.

Initial Calculations utilizing worst case predicted values are made for safe distances in Feet and Meters for Hero Unsafe/Unreliable Ordnance, Hero Susceptible Ordnance and Hero Safe Ordnance (as defined below).

(a) HERO SAFE ORDNANCE - Any ordnance item that is sufficiently shielded, or otherwise so protected that all EED's contained by the item are immune to adverse effects (safety or reliability) when the item is employed in its expected RF environments, provided that the general HERO requirements are observed. Percussion-initiated ordnance is exempt from HERO requirements. **Example (1 Amp / 1 Watt shielded lead EED).**

(b) HERO SUSCEPTIBLE ORDNANCE - Any ordnance containing EED’s proven (by test or analysis) to be adversely affected by RF energy to the point that the safety and/or reliability of the system is in jeopardy when the system is employed in expected RF environments.

(c) HERO UNRELIABLE ORDNANCE – Any ordnance item, including those having the above classifications, whose performance is degraded due to exposure to the RF environment when its internal wiring is physically exposed; when tests are being conducted on the item that result in additional electrical connections to the item; when EED’s having exposed wire leads are present, handled, or loaded in any but the tested condition; when the item is being assembled or disassembled; or when such ordnance items are damaged causing exposure of internal wiring or components or destroying engineered HERO protective devices. This ordnance is subject to the restrictions of OP 3565 chapter 2, figures 2-1 and 2-2.

(d) HERO UNSAFE ORDNANCE – Any ordnance item, including those having the above classifications, whose internal wiring is physically exposed to an RF environment that may cause accidental initiation or detonation, when tests are being conducted on the item that result in additional electrical connections to the item; when EED’s having exposed wire leads are present, handled, or loaded in any but the tested condition; when the item is being assembled or disassembled; or when such ordnance items are damaged causing exposure of internal wiring or components or destroying engineered HERO protective devices. This ordnance is subject to the restrictions of OP 3565 chapter 2, figures 2-1 and 2-2.

From the OP 3565 DOD approved Calculator the following values are obtained:

L-Band Telemetry Transmitter HERO

HERO SAFE SEPARATION DISTANCE CALCULATOR		
Transmitter Nomenclature:	L-Band TM Transmitter	(Optional)
Antenna Nomenclature:	Omni, Below Gondola	(Optional)
Transmitter Start or Lower Frequency:	1444.5	MHz
Transmitter Maximum Average Output Power:	2.000	Watts
Antenna Gain:	1.0	dBi
Calculated Effective Isotropic Radiated Power (EIRP):	2.518	Watts
HERO UNSAFE or HERO UNRELIABLE ORDNANCE	10 3.0	Feet Meters
HERO SUSCEPTIBLE ORDNANCE	10 3.0	Feet Meters
HERO SAFE ORDNANCE	5 1.5	Feet Meters

Upper L-Band Video Telemetry Transmitter HERO

HERO SAFE SEPARATION DISTANCE CALCULATOR		
Transmitter Nomenclature:	Upper L-Band Video TM Transmitter	(Optional)
Antenna Nomenclature:	Omni, Below Gondola	(Optional)
Transmitter Start or Lower Frequency:	1845.0	MHz
Transmitter Maximum Average Output Power:	10.000	Watts
Antenna Gain:	1.0	dBi
Calculated Effective Isotropic Radiated Power (EIRP):	12.589	Watts
HERO UNSAFE or HERO UNRELIABLE ORDNANCE	10 3.0	Feet Meters
HERO SUSCEPTIBLE ORDNANCE	10 3.0	Feet Meters
HERO SAFE ORDNANCE	10 3.0	Feet Meters

S-Band Telemetry Transmitter HERO

HERO SAFE SEPARATION DISTANCE CALCULATOR		
Transmitter Nomenclature:	S-Band TM Transmitter	(Optional)
Antenna Nomenclature:	Omni, Below Gondola	(Optional)
Transmitter Start or Lower Frequency:	2388.5	MHz
Transmitter Maximum Average Output Power:	10.000	Watts
Antenna Gain:	1.0	dBi
Calculated Effective Isotropic Radiated Power (EIRP):	12.589	Watts
HERO UNSAFE or HERO UNRELIABLE ORDNANCE	10 3.0	Feet Meters
HERO SUSCEPTIBLE ORDNANCE	10 3.0	Feet Meters
HERO SAFE ORDNANCE	10 3.0	Feet Meters

UHF Transmitter HERO

HERO SAFE SEPARATION DISTANCE CALCULATOR		
Transmitter Nomenclature:	UHF Transmitters	(Optional)
Antenna Nomenclature:	Omni, Below Gondola	(Optional)
Transmitter Start or Lower Frequency:	403.0	MHz
Transmitter Maximum Average Output Power:	5.000	Watts
Antenna Gain:	1.0	dBi
Calculated Effective Isotropic Radiated Power (EIRP):	6.259	Watts
HERO UNSAFE or HERO UNRELIABLE ORDNANCE	18 5.5	Feet Meters
HERO SUSCEPTIBLE ORDNANCE	10 3.0	Feet Meters
HERO SAFE ORDNANCE	5 1.5	Feet Meters

FAA Transponder HERO

HERO SAFE SEPARATION DISTANCE CALCULATOR		
Transmitter Nomenclature:	FAA Transponder	(Optional)
Antenna Nomenclature:	Omni, Below Gondola	(Optional)
Transmitter Start or Lower Frequency:	1090.0	MHz
Transmitter Maximum Average Output Power:	150.000	Watts
Antenna Gain:	1.0	dBi
Calculated Effective Isotropic Radiated Power (EIRP):	188.839	Watts
HERO UNSAFE or HERO UNRELIABLE ORDNANCE	36 11.0	Feet Meters
HERO SUSCEPTIBLE ORDNANCE	10 3.0	Feet Meters
HERO SAFE ORDNANCE	10 3.0	Feet Meters

TDRSS TM Transmitter – Omni Antenna - HERO

HERO SAFE SEPARATION DISTANCE CALCULATOR		
Transmitter Nomenclature:	TDRSS TM Transmitter	(Optional)
Antenna Nomenclature:	Omni, Above Gondola	(Optional)
Transmitter Start or Lower Frequency:	2287.5	MHz
Transmitter Maximum Average Output Power:	3.200	Watts
Antenna Gain:	1.0	dBi
Calculated Effective Isotropic Radiated Power (EIRP):	4.029	Watts
HERO UNSAFE or HERO UNRELIABLE ORDNANCE	10 3.0	Feet Meters
HERO SUSCEPTIBLE ORDNANCE	10 3.0	Feet Meters
HERO SAFE ORDNANCE	5 1.5	Feet Meters

TDRSS TM Transmitter –Directional Antenna - HERO

HERO SAFE SEPARATION DISTANCE CALCULATOR		
Transmitter Nomenclature:	TDRSS TM Transmitter	(Optional)
Antenna Nomenclature:	Directional, Above Gondola	(Optional)
Transmitter Start or Lower Frequency:	2287.5	MHz
Transmitter Maximum Average Output Power:	3.200	Watts
Antenna Gain:	18.0	dBi
Calculated Effective Isotropic Radiated Power (EIRP):	201.906	Watts
HERO UNSAFE or HERO UNRELIABLE ORDNANCE	18 5.4	Feet Meters
HERO SUSCEPTIBLE ORDNANCE	10 3.0	Feet Meters
HERO SAFE ORDNANCE	10 3.0	Feet Meters

Iridium Telemetry Transmitter HERO

HERO SAFE SEPARATION DISTANCE CALCULATOR		
Transmitter Nomenclature:	Iridium Transmitter	(Optional)
Antenna Nomenclature:	Omni, Above Gondola	(Optional)
Transmitter Start or Lower Frequency:	1626.5	MHz
Transmitter Maximum Average Output Power:	0.570	Watts
Antenna Gain:	1.0	dBi
Calculated Effective Isotropic Radiated Power (EIRP):	0.718	Watts
HERO UNSAFE or HERO UNRELIABLE ORDNANCE	10 3.0	Feet Meters
HERO SUSCEPTIBLE ORDNANCE	10 3.0	Feet Meters
HERO SAFE ORDNANCE	5 1.5	Feet Meters

UHF: "Bitty Box" Payload/Vehicle Command & Control HERO

HERO SAFE SEPARATION DISTANCE CALCULATOR		
Transmitter Nomenclature:	UHF "Bitty Box"	(Optional)
Antenna Nomenclature:	Omni	(Optional)
Transmitter Start or Lower Frequency:	429.5	MHz
Transmitter Maximum Average Output Power:	5.000	Watts
Antenna Gain:	1.0	dBi
Calculated Effective Isotropic Radiated Power (EIRP):	6.295	Watts
HERO UNSAFE or HERO UNRELIABLE ORDNANCE	17 5.1	Feet Meters
HERO SUSCEPTIBLE ORDNANCE	10 3.0	Feet Meters
HERO SAFE ORDNANCE	10 3.0	Feet Meters

UHF: "Bitty Box" Payload/Vehicle Command & Control HERO Ground Station

HERO SAFE SEPARATION DISTANCE CALCULATOR		
Transmitter Nomenclature:	UHF "Bitty Box"	(Optional)
Antenna Nomenclature:	Omni	(Optional)
Transmitter Start or Lower Frequency:	429.5	MHz
Transmitter Maximum Average Output Power:	100.000	Watts
Antenna Gain:	14.0	dBi
Calculated Effective Isotropic Radiated Power (EIRP):	2511.886	Watts
HERO UNSAFE or HERO UNRELIABLE ORDNANCE	335 102.2	Feet Meters
HERO SUSCEPTIBLE ORDNANCE	84 25.5	Feet Meters
HERO SAFE ORDNANCE	10 3.0	Feet Meters

VHF DTMF Handie-Talkie: CSBF Collar Command HERO

HERO SAFE SEPARATION DISTANCE CALCULATOR		
Transmitter Nomenclature:	VHF DTMF Handie-Talkie	(Optional)
Antenna Nomenclature:	Omni	(Optional)
Transmitter Start or Lower Frequency:	138.5	MHz
Transmitter Maximum Average Output Power:	5.000	Watts
Antenna Gain:	1.0	dBi
Calculated Effective Isotropic Radiated Power (EIRP):	6.295	Watts
HERO UNSAFE or HERO UNRELIABLE ORDNANCE	52 15.9	Feet Meters
HERO SUSCEPTIBLE ORDNANCE	13 4.0	Feet Meters
HERO SAFE ORDNANCE	10 3.0	Feet Meters

VHF: CSBF and Science Voice Communications HERO

HERO SAFE SEPARATION DISTANCE CALCULATOR		
Transmitter Nomenclature:	CSBF Science & Voice Comms	(Optional)
Antenna Nomenclature:	Omni	(Optional)
Transmitter Start or Lower Frequency:	138.0	MHz
Transmitter Maximum Average Output Power:	5.000	Watts
Antenna Gain:	1.0	dBi
Calculated Effective Isotropic Radiated Power (EIRP):	6.295	Watts
HERO UNSAFE or HERO UNRELIABLE ORDNANCE	52 15.9	Feet Meters
HERO SUSCEPTIBLE ORDNANCE	13 4.0	Feet Meters
HERO SAFE ORDNANCE	10 3.0	Feet Meters

VHF: CSBF and Science Voice Communications HERO Ground Station

HERO SAFE SEPARATION DISTANCE CALCULATOR		
Transmitter Nomenclature:	CSBF Science & Voice Comms	(Optional)
Antenna Nomenclature:	Omni	(Optional)
Transmitter Start or Lower Frequency:	138.0	MHz
Transmitter Maximum Average Output Power:	100.000	Watts
Antenna Gain:	3.0	dBi
Calculated Effective Isotropic Radiated Power (EIRP):	199.526	Watts
HERO UNSAFE or HERO UNRELIABLE ORDNANCE	294 89.7	Feet Meters
HERO SUSCEPTIBLE ORDNANCE	73 22.4	Feet Meters
HERO SAFE ORDNANCE	10 3.0	Feet Meters

VHF: Airfield Operations, Unicom Frequency HERO Ground Station

HERO SAFE SEPARATION DISTANCE CALCULATOR		
Transmitter Nomenclature:	Airfield Operations	(Optional)
Antenna Nomenclature:	Omni	(Optional)
Transmitter Start or Lower Frequency:	108.0	MHz
Transmitter Maximum Average Output Power:	2.000	Watts
Antenna Gain:	3.0	dBi
Calculated Effective Isotropic Radiated Power (EIRP):	3.991	Watts
HERO UNSAFE or HERO UNRELIABLE ORDNANCE	53 16.2	Feet Meters
HERO SUSCEPTIBLE ORDNANCE	13 4.0	Feet Meters
HERO SAFE ORDNANCE	5 1.5	Feet Meters

MIP: CSBF Payload Communications HERO

HERO SAFE SEPARATION DISTANCE CALCULATOR		
Transmitter Nomenclature:	payload	(Optional)
Antenna Nomenclature:		(Optional)
Transmitter Start or Lower Frequency:	406.2	MHz
Transmitter Maximum Average Output Power:	5.000	Watts
Antenna Gain:	3.0	dBi
Calculated Effective Isotropic Radiated Power (EIRP):	9.976	Watts
HERO UNSAFE or HERO UNRELIABLE ORDNANCE	22	Feet
	6.8	Meters
HERO SUSCEPTIBLE ORDNANCE	10	Feet
	3.0	Meters
HERO SAFE ORDNANCE	10	Feet
	3.0	Meters

ISM Band: SPB Tow Balloon Communications HERO

HERO SAFE SEPARATION DISTANCE CALCULATOR		
Transmitter Nomenclature:	ISM	(Optional)
Antenna Nomenclature:		(Optional)
Transmitter Start or Lower Frequency:	2400.0	MHz
Transmitter Maximum Average Output Power:	0.100	Watts
Antenna Gain:	3.0	dBi
Calculated Effective Isotropic Radiated Power (EIRP):	0.200	Watts
HERO UNSAFE or HERO UNRELIABLE ORDNANCE	10	Feet
	3.0	Meters
HERO SUSCEPTIBLE ORDNANCE	5	Feet
	1.5	Meters
HERO SAFE ORDNANCE	1	Feet
	0.3	Meters

MINIMUM SEPARATION DISTANCE (FT.)	HERO CLASSIFICATION		
	SAFE	SUSCEPTIBLE	UNSAFE OR UNRELIABLE
$\geq$ 10	General HERO Requirements	Use Calculated Distance per OP 3565	Use Calculated Distance per OP 3565
5	0.5 < EIRP $\leq$ 5 watts All Frequencies	EIRP $\leq$ 0.5 watts Frequencies $\geq$ 100 MHz	0.025 < EIRP $\leq$ 0.1 watts 200 MHz $\leq$ Freq < 1 GHz
1	0.1 < EIRP $\leq$ 0.5 watts All Frequencies	0.025 < EIRP $\leq$ 0.1 watts Frequencies $\geq$ 200 MHz	0.025 < EIRP $\leq$ 0.1 watts Frequencies $\geq$ 1 GHz
0	EIRP $\leq$ 0.1 watts All Frequencies	EIRP $\leq$ 0.025 watts All Frequencies	EIRP $\leq$ 0.025 watts Frequencies $\geq$ 100 MHz

All ORDNANCE

Maintain 1.5 meters (5 feet) from rigid waveguide routed through magazines.

HERO SAFE ORDNANCE

Maintain 1.5 meters (5 feet) from the vertical projection of a lowered deck-edge antenna with the transmitter operating at an average Effective Isotropic Radiated Power (EIRP) of 1000 watts or less, provided all loading procedures have been completed.
Maintain a minimum separation of 15 meters (50 feet) from any transmitting shipboard antenna during vertical replenishment (VERTREP) operations.

$EIRP = P_t \times G_t$

Where:

EIRP is the effective isotropic radiated power in watts.

P_t is the average power output of the transmitter in watts.

G_t is the numerical (far-field) gain ratio (not the dB value) of the transmitting antenna, derived as follows:

$Gt = 1 \times 10^{G/10}$ where

G = gain in dBi

Example: If the antenna far-field gain is 2.1 dBi, the far-field gain ratio is

$1 \times 10^{2.1/10} = 1 \times 10^{0.21} = 1.62$

4. Pressure Vessel Danger Area Calculations:

Helium Truck (Isopack) Danger Area calculation:

Danger Area calculations are based upon standard pressure vessel calculations. To determine the TNT equivalence (in pounds) of a pressure vessel, we use the following equation:

$$E = C\left\{\frac{P_1V_1}{K-1}\left[1 - \left(\frac{P_2}{P_1}\right)^{\frac{K-1}{K}}\right]\right\}$$

Where E = Energy (TNT equivalence in pounds)
C = Constant (for pounds TNT) = 9.22 (10^{-5})
P_2 = Standard Pressure = 14.7 psia
P_1 = Operating Pressure + P_2
V_1 = Volume (feet^3)
K = Specific Heat Ratio (Helium K = 1.66)

Once the Energy equivalent is calculated, we can then calculate the Danger Area Radius using the equation:

$$\mathbf{R = k\,(E^{1/3})}$$

Where R = Danger Area Radius (feet)
k = the factor of safety
E = Energy (TNT equivalence in pounds) from above

Calculation for Helium Truck (Tube bank trailer) is not required as long as it meets or exceeds DOT specifications since Helium will be vented into balloon. If not DOT approved tube bank trailer, notify NASA Safety before use for evaluation by NASA Pressure Systems Manager (PSM).

Helium Truck clear for non-essential personnel shall be 15 meters (50 feet) centered on the vehicle)

High Pressure Hose Danger Area calculation:

Using the AF Space Command Manual 91-710, Volume 3, Section 11, Table 11.2, to obtain the Force Factor for a ½" ID hose, and using the given hose pressure of 3500 psi, an Open Line Force Calculation reveals that a force of 1679 pounds will occur at the end of the inflation hose if the end fitting fails. In lieu of sufficient mitigating factors showing that an equivalent force can be applied to restrain the hose, or the open line force can be diminished, the hazard area around this hose will be the entire length of the hose, which is 300 feet then equalized with launch vehicle clear 315 ft.

ENCLOSURE 4 HAZARD REPORTS

HAZARD REPORT NUMBER Balloon HR-1

PROJECT Balloon ***AUTHOR*** Maxfield/Ball

ID 224 ***LAST MODIFIED*** 1/20/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Personnel injured by falling debris

HAZARD DESCRIPTION
Table weights left in the balloon at the factory fall from the balloon during inflation and injure personnel.

HAZARD CAUSE
1. Table Weight left in the balloon.

HAZARD EFFECTS
Death, Injury or Property Damage

HAZARD CONTROLS
1.1. At the factory, prior to running the closing seal in the balloon, all weights are placed in cubby holes mounted on the manufacturing tables. If there are any empty cubby holes, the balloon is examined to locate the missing weight. All cubby holes must be filled with a weight before the balloon is closed. 1.2. Table weights are color coded and assigned to individual tables to preclude stray weights being used. 1.3. While loading the balloon into the box at the factory, a metal detector is passed over the entire length of the balloon to locate any table weights that may have been left in the balloon. 1.4. A visual inspection of the balloon is conducted while it is being laid out on the flight line prior to start of inflation.

CONTROLS VERIFICATION
1.1.1. Aerostar manufacturing and CSBF quality assurance personnel are assigned responsibility to check cubby holes for missing weights. 1.2.1. Aerostar plant quality control and CSBF quality assurance personnel are assigned to insure that color code procedures are followed. 1.3.1. Aerostar manufacturing personnel and CSBF quality assurance personnel are assigned responsibility to insure that the metal detector finds no metal objects in the balloon during loading. 1.4.1. Operations personnel are trained in spotting anomalous protrusions in the balloon during lay out.

VERIFICATION STATUS
1.1.1. CLOSED. 1.2.1. CLOSED. 1.3.1. CLOSED. 1.4.1. CLOSED.

INITIAL RISK SEVERITY I

INITIAL MISHAP PROBABILITY C

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY I

INTERIM MISHAP PROBABILITY D

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Reviewed January 2016 by Z. Moore, no changes.

HAZARD REPORT NUMBER Balloon HR-2

PROJECT Balloon ***AUTHOR*** Maxfield/Ball/Moore/Garde

ID 225 ***LAST MODIFIED*** 2/8/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
High pressure gas fitting/equipment failure

HAZARD DESCRIPTION
Personnel injured by gas &/or flying objects due to failure of high pressure gas fittings or equipment.

HAZARD CAUSE
1. Faulty fitting. 2. Faulty hose. 3. Faulty assembly. 4. Faulty operation. 5. Nonessential personnel in Hazard area.

HAZARD EFFECTS
Death, Injury or Property Damage

HAZARD CONTROLS
1.1. Fitting design specifications are sufficient to meet the intended purpose. 1.2. Fittings are inspected annually by qualified independent inspectors as part of the WFF pressure systems certification program. 1.3. Crew Chief verifies inspection status of fittings prior to packing for remote campaigns. 1.4. Whip socks are installed on all fittings to provide hazard mitigation in case of failure or inadvertent disconnection. 2.1. Hose design specifications are sufficient to meet the intended purpose. 2.2. Hoses are inspected annually by qualified independent inspectors as part of the WFF pressure systems certification program. 2.3. Crew Chief verifies inspection status of hoses prior to packing for remote campaigns. 3.1. Launch crew is trained to assemble hose fittings properly. 3.2. Crew Chief inspects hose assemblies prior to start of inflation. 4.1. Fluorescent cones are placed around operational areas where hoses are used to prevent vehicles and heavy equipment from running over hoses. 4.2. Crew members are trained to react appropriately to a series of hand signals from the Crew Chief indicating status and desired actions during high pressure operations. 5.1. Non-essential personnel are not allowed in Hazard areas.

CONTROLS VERIFICATION
1.1.1. Engineering analysis and past purchases. 1.2.1. Annual report is written on formal inspections and testing by inspectors as part of the WFF pressure systems certification program. 1.2.2. Tag out system is used for equipment failing tests. 1.3.1. SOP. 1.3.2. Crew Chief packing check list indicates that only certified hoses should be sent to the launch site. 1.4.1. SOP. 2.1.1. Engineering analysis and past purchases. 2.2.1. Annual report is written on formal inspections and testing by inspectors as part of the WFF pressure systems certification program. 2.2.2. Tag out system is used for equipment failing tests. 2.3.1. SOP. 2.3.2. Crew Chief packing check list indicates that only certified hoses should be sent to the launch site. 3.1.1. Crew Training. 3.2.1. SOP. 4.1.1. SOP. 4.1.2. Crew Chief and Campaign Manager verify cone placement as part of general Specialty inspections during operations. 4.2.1. Training in handling and signals of high pressure systems is part of a documented Balloon Technician training program. 4.2.2. Records are maintained of tasks crew members have been trained to perform. 5.1.1. Hazard area enforced by Operations Safety Specialist (OSS) / Mission Range Safety Officer (MRSO).

VERIFICATION STATUS
1.1.1. CLOSED. 1.2.1. CLOSED. 1.2.2. CLOSED. 1.3.1. CLOSED. 1.3.2. CLOSED. 1.4.1. CLOSED. 2.1.1. CLOSED. 2.2.1. CLOSED. 2.2.2. CLOSED. 2.3.1. CLOSED. 2.3.2. CLOSED. 3.1.1. CLOSED. 3.2.1. CLOSED. 4.1.1. CLOSED. 4.1.2. CLOSED. 4.2.1. CLOSED. 4.2.2. CLOSED. 5.1.1. CLOSED.

INITIAL RISK SEVERITY I ***INTERIM RISK SEVERITY*** I

INITIAL MISHAP PROBABILITY C ***INTERIM MISHAP PROBABILITY*** D

INITIAL RISK ASSESSMENT CODE 1 ***INTERIM RISK ASSESSMENT CODE*** 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Updated pressure systems certification program. Reviewed February 2016 by Z. Moore and G. Garde, no additional changes.

HAZARD REPORT NUMBER Balloon HR-3

PROJECT Balloon ***AUTHOR*** Maxfield/Ball

ID 226 ***LAST MODIFIED*** 1/20/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Premature/Inadvertent Payload Release

HAZARD DESCRIPTION
Personnel injured &/or property damaged by payload falling from launch vehicle prior to launch.

HAZARD CAUSE
1. Failure of any mechanical component in the flight train below and including the truck plate. 2. Failure of launch head pin, load bearing launch head components, or launch head attachment assembly. 3. Failure of launch vehicle boom. 4. Nonessential personnel in Hazard area.

HAZARD EFFECTS
Death, Injury or Property Damage

HAZARD CONTROLS
1.1. Documented flight train engineering certification has a 10g vertical and 5g at 45 degree strength requirement which far exceeds any possible load that could be encountered while payload is suspended from the launch vehicle. 2.1. Documented LECC (launch equipment certification) process insures all launch equipment including launch head pin, load bearing launch head components, and launch head attachment assembly can withstand forces exerted on launch head at the maximum planned gross inflation including forces that may be induced by a 22 knot wind from behind the fully inflated balloon bubble. There are two mechanical inhibitors in the payload suspension system on the launch head: the launch head pin; and a set of restraining cables attached to the launch head and truck plate capable of supporting the payload should the launch head pin fail. 3.1. A mechanical “dead man” support beam is set in place once the boom is raised to a height appropriate for the operation. The dead man prevents the boom from falling in the event of hydraulic failure in the boom system. 4.1. Non-essential personnel are not allowed in Hazard areas.

CONTROLS VERIFICATION
1.1.1. Engineering analysis is documented in the flight train certification procedure. 2.1.1 Engineering analysis and pull testing of the launch and spool vehicle assemblies is carried out and documented at the beginning of each campaign. 3.1.1 Final step in payload pickup process is setting the dead man. Crew Chief and Campaign Manager insure it is set and locked. 4.1.1. Hazard area enforced by OSS / Mission Range Safety Officer (MRSO).

VERIFICATION STATUS
1.1.1. CLOSED. 2.1.1. CLOSED. 3.1.1. CLOSED. 4.1.1. CLOSED.

INITIAL RISK SEVERITY I

INITIAL MISHAP PROBABILITY C

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY I

INTERIM MISHAP PROBABILITY D

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Reviewed January 2016 by Z. Moore, no changes.

HAZARD REPORT NUMBER Balloon HR-4

PROJECT Balloon ***AUTHOR*** Maxfield/Ball/Moore/Garde

ID 227 ***LAST MODIFIED*** 2/8/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Premature/Inadvertent Balloon Release

HAZARD DESCRIPTION
Personnel injured &/or property damaged by premature balloon release during inflation due to failure of mechanical restraints or unplanned firing of terminate pyrotechnics.

HAZARD CAUSE
1. Mechanical failure in Flight Train. 2. Mechanical failure in Spool. 3. Premature/inadvertent activation of separation pyrotechnics. 4. For hand launch operations, personnel failure. 5. Nonessential personnel in Hazard area.

HAZARD EFFECTS
Death, Injury or Property Damage

HAZARD CONTROLS
1.1. Documented flight train engineering certification has 10g vertical and 5g at 45 degree strength requirement, far exceeding any possible load that could be encountered during inflation. 2.1. Documented LECC (launch equipment certification) process insures all launch equipment including the spool assembly and launch vehicle can withstand forces exerted at the maximum planned gross inflation including forces induced by a 22 knot wind from behind the fully inflated balloon bubble. 2.2. The LECC process includes mechanical pull tests & engineering analysis conducted at the beginning of each campaign. 3.1. Pyrotechnics comply with NASA explosives specifications. 3.2. Firing circuitry is compliant with Mil-STD-1576 for grounding, shielding, and bleed resistors. 3.3. Firing circuitry arm and fire functions require two commands to initiate the pyrotechnics. 3.4. The parachute and ground cloths on which the pyrotechnics lie during inflation are treated with anti-static fluid to prevent electrostatic discharge. 3.5. The operator must make a double entry, arm and fire are separate commands, to initiate the pyrotechnics. 4.1. Launch operations personnel are trained for hand launches. 4.2. Launch location conditioned and clear of impedimenta. 5.1. Non-essential personnel are not allowed in Hazard areas.

CONTROLS VERIFICATION
1.1.1. Engineering analysis is documented in the flight train certification procedure. 2.1.1. Engineering analysis and pull testing of the launch and spool vehicle assemblies is carried out and documented at the beginning of each campaign. 3.1.1. Compliant specifications for pyrotechnics are standard to CSBF assemblies. 3.2.1. Compliant specifications for firing circuitry are standard to CSBF systems. 3.3.1. The two command requirement for pyrotechnic initiation is standard to CSBF flight trains. 3.4.1. Compliant specifications are standard to CSBF staticides. 3.5.1. The double entry requirement for pyrotechnic initiation is standard to CSBF GSE. 4.1.1. Training done via technician career path system. 4.2.1. Visual inspection of hazard area. 5.1.1. Hazard area enforced by OSS / Mission Range Safety Officer (MRSO).

VERIFICATION STATUS
1.1.1. CLOSED. 2.1.1. CLOSED. 3.1.1. CLOSED. 3.2.1. CLOSED. 3.3.1. CLOSED. 3.4.1. CLOSED. 3.5.1. CLOSED. 4.1.1. CLOSED. 4.2.1. CLOSED. 5.1.1. CLOSED.

INITIAL RISK SEVERITY I

INITIAL MISHAP PROBABILITY C

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY I

INTERIM MISHAP PROBABILITY D

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Updated 3 in Hazard Cause and 3.5 in Controls verification. Reviewed February 2016 by Z. Moore and G. Garde, no additional changes.

HAZARD REPORT NUMBER Balloon HR-5

PROJECT Balloon ***AUTHOR*** Maxfield/Ball

ID 228 ***LAST MODIFIED*** 1/20/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Mechanical Failure of Flight Train

HAZARD DESCRIPTION
Personnel injured &/or property damaged by failure of Flight Train & subsequent whip action.

HAZARD CAUSE
1. Normal loading from balloon lift exceeds Flight Train strength. 2. Higher than normal drag from extreme wind loading exceeds Flight Train strength. 3. Nonessential personnel in Hazard area.

HAZARD EFFECTS
Death, Injury or Property Damage

HAZARD CONTROLS
1.1. Documented flight train engineering certification has a 10g vertical and 5g at 45 degree strength requirement which far exceeds any possible load that could be encountered during inflation. The very high strength requirements are necessitated by forces encountered at the end of the flight during parachute opening. 1.2. The LECC process includes mechanical pull tests in addition to engineering analysis and is conducted at the beginning of each campaign. 2.1. Documented LECC (launch equipment certification) process insures all launch equipment including the spool assembly and launch vehicle can withstand forces exerted at the maximum planned gross inflation including forces that may be induced by a 22 knot wind from behind the fully inflated balloon bubble. 2.2. CSBF meteorological forecasts are used to insure that winds remain within acceptable levels. 2.3. Should excessive winds be encountered, helium valves at the top of the balloon are opened causing the balloon to lose lift and deflate. 3.1. Non-essential personnel are not allowed in Hazard areas.

CONTROLS VERIFICATION
1.1.1. Engineering analysis is documented in the flight train certification procedure. 1.2.1. Engineering analysis and pull testing of the launch and spool vehicle assemblies is carried out and documented at the beginning of each campaign as part of the LECC. 2.1.1. LECC process is documented at the beginning of each campaign. 2.2.1. Meteorological briefings are carried out prior to the start of each operation. 2.3.1. Crew Chiefs are updated after the operation begins as required. 2.3.2. Helium valve opening in the event of unexpected extreme winds is standard operating procedure. 3.1.1. Hazard area enforced by OSS / Mission Range Safety Officer (MRSO).

VERIFICATION STATUS
1.1.1. CLOSED. 1.2.1 CLOSED. 2.1.1. CLOSED. 2.2.1. CLOSED. 2.3.1. CLOSED. 2.3.2. CLOSED. 3.1.1. CLOSED.

INITIAL RISK SEVERITY I

INITIAL MISHAP PROBABILITY C

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY I

INTERIM MISHAP PROBABILITY D

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Reviewed January 2016 by Z. Moore, no changes.

HAZARD REPORT NUMBER Balloon HR-6

PROJECT Balloon ***AUTHOR*** Maxfield/Ball/Moore/Garde

ID 229 ***LAST MODIFIED*** 1/26/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Premature/Inadvertent EED Event

HAZARD DESCRIPTION
Balloon, collar or Super Pressure Balloon inflation tube released due to premature/inadvertent EED event during launch operations.

HAZARD CAUSE
1. Defective EED. 2. RF energy present on bridge wires. 3. Electro-static Discharge (ESD). 4. Defective test equipment. 5. Improper use of GSE. 6. Nonessential personnel in Hazard area.

HAZARD EFFECTS
Death, Injury or Property Damage

HAZARD CONTROLS
1.1. Shorted, shielded and grounded bridgewire leads. 1.2. EED tested per ES-100-20-P. 2.1. RF silence any time bridgewires leads are exposed. 3.1. Required grounding of pyros, components, GSE and personnel. 3.2. Annual testing/certification of facility ordnance grounding points at established launch facilities (Palestine and Fort Sumner). 3.3. Utilization of conductive ground cloths for launch operations. 3.4. Personal Protective Equipment (wrist straps, static-dissipating lab coats, etc.) required. 4.1. Initial testing, calibration and scheduled recalibration of all measuring equipment. 4.2. Normal pre-testing check per ES-100-20-P. 5.1. Qualified personnel to perform EED installation and connection. 5.2. Operation is performed per ES-100-20-P. 6.1. Non-essential personnel are not allowed in Hazard areas.

CONTROLS VERIFICATION
1.1.1. Standard practice for ordnance handling and manufacturing. 1.2.1. Ground Safety Group review/approval of EEDs procedure. 2.1.1. OSS verifies. 3.1.1. Specified in operational procedures. 3.1.2. OSS verifies. 3.2.1. Specified in operational procedures, per NASA regulations. 3.2.2. OSS verifies. 3.3.1. Specified in operational procedures, per NASA regulations. 3.3.2. Static dissipative agent sprayed on ground cloth. 3.3.3. OSS verifies. 3.4.1. Specified in operational procedures, per NASA regulations. 3.4.2. OSS verifies. 4.1.1. Specified in operational procedures, per NASA regulations. 4.1.2. OSS verifies. 4.2.1. Specified in operational procedures, per NASA regulations. 4.2.2. OSS verifies. 5.1.1. Recurrent Training & Certification of ordnance handlers by WFF Explosive Safety Officer (ESO). 5.1.2. OSS verifies. 5.2.1. Specified in operational procedures, per NASA regulations. 5.2.2. OSS verifies. 6.1.1. Hazard area enforced by OSS / Mission Range Safety Officer (MRSO).

VERIFICATION STATUS
1.1.1. CLOSED. 1.2.1. CLOSED. 2.1.1. CLOSED. 3.1.1. CLOSED. 3.1.2. CLOSED. 3.2.1. CLOSED. 3.2.2. CLOSED. 3.3.1. CLOSED. 3.3.2. CLOSED. 3.3.3. CLOSED. 3.4.1. CLOSED. 3.4.2. CLOSED. 4.1.1. CLOSED. 4.1.2. CLOSED. 4.2.1. CLOSED. 4.2.2. CLOSED. 5.1.1. CLOSED. 5.1.2. CLOSED. 5.2.1. CLOSED. 5.2.2. CLOSED. 6.1.1. CLOSED.

INITIAL RISK SEVERITY I

INITIAL MISHAP PROBABILITY C

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY I

INTERIM MISHAP PROBABILITY D

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Section 2 and 3 updated rest renumbered. Reviewed January 2016 by Z. Moore and G. Garde, no additional changes.

HAZARD REPORT NUMBER Balloon HR-7

PROJECT Balloon ***AUTHOR*** Maxfield/Ball

ID 230 ***LAST MODIFIED*** 1/20/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Spool Released into Crew Member

HAZARD DESCRIPTION
Crew Member Struck by Spool

HAZARD CAUSE
1. Spool released prematurely by failure of spool assembly. 2. Spool released accidently by crew member. 3. Crew member is standing out of place.

HAZARD EFFECTS
Death, Injury or Property Damage

HAZARD CONTROLS
1.1. Documented LECC (launch equipment certification) process insures all launch equipment including the spool assembly and latch can withstand forces exerted at the maximum planned gross inflation including forces that may be induced by a 22 knot wind from behind the fully inflated balloon bubble. 1.2. The LECC process includes mechanical pull tests in addition to engineering analysis and is conducted at the beginning of each campaign. 2.1. The spool mechanism has a safety pin which disables the spool release mechanism; the pin is never removed until immediately prior to the Crew Chief's instruction to release the balloon. 3.1. Spool Operator is trained to look for personnel in the spool pathway prior to pulling the spool release lever. 3.2. Crew members are trained to stay out of the spool pathway. 3.3. The OSS keeps people out of the spool pathway.

CONTROLS VERIFICATION
1.1.1 Documented engineering analysis. 1.2.1. Engineering analysis and pull testing of the launch and spool vehicle assemblies is carried out and documented at the beginning of each campaign. 2.1.1. Standard Spool Latch design; standard operating procedure. 3.1.1. Crew training via Balloon technician career path system. 3.2.1. Crew training via Balloon technician career path system. 3.3.1. OSS verification.

VERIFICATION STATUS
1.1.1. CLOSED. 1.2.1. CLOSED. 2.1.1. CLOSED. 3.1.1. CLOSED. 3.2.1. CLOSED. 3.3.1. CLOSED.

INITIAL RISK SEVERITY I

INITIAL MISHAP PROBABILITY C

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY I

INTERIM MISHAP PROBABILITY D

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Reviewed January 2016 by Z. Moore, no changes.

HAZARD REPORT NUMBER Balloon HR-8

PROJECT Balloon ***AUTHOR*** Maxfield/Ball ***ID*** 231 ***LAST MODIFIED*** 1/21/2016

HAZARDOUS SUBSYSTEM/OPERATION Balloon Launch Operations

HAZARD DESCRIPTOR Balloon Burst during Inflation

HAZARD DESCRIPTION Personnel injured by balloon falling after a tear in the shell material allows the gas to escape.

HAZARD CAUSE

1. Balloon material failure. 2. High velocity helium gas tears the balloon material. 3. Catastrophic failure in a balloon seal. 4. Excessive surface wind destroys the balloon.

HAZARD EFFECTS Death, Injury or Property Damage

HAZARD CONTROLS

1.1. Documented material and production quality control and quality assurance program during balloon manufacturing. 1.2. Training program on balloon inflation techniques for control of gas pressure and inflation tube handling. 1.3. Documented material and production quality control and quality assurance program during balloon manufacturing. 1.4. Staff meteorologists continuously monitor and advise Crew Chief of potential for strong surface winds during operations. 1.5. Non-essential personnel are not allowed in Hazard areas. 2.1. Documented material and production quality control and quality assurance program during balloon manufacturing. 2.2. Training program on balloon inflation techniques for control of gas pressure and inflation tube handling. 2.3. Documented material and production quality control and quality assurance program during balloon manufacturing. 2.4. Staff meteorologists continuously monitor and advise Crew Chief of potential for strong surface winds during operations. 2.5. Non-essential personnel are not allowed in Hazard areas. 3.1. Documented material and production quality control and quality assurance program during balloon manufacturing. 3.2. Training program on balloon inflation techniques for control of gas pressure and inflation tube handling. 3.3. Documented material and production quality control and quality assurance program during balloon manufacturing. 3.4. Staff meteorologists continuously monitor and advise Crew Chief of potential for strong surface winds during operations. 3.5. Non-essential personnel are not allowed in Hazard areas. 4.1. Documented material and production quality control and quality assurance program during balloon manufacturing. 4.2. Training program on balloon inflation techniques for control of gas pressure and inflation tube handling. 4.3. Documented material and production quality control and quality assurance program during balloon manufacturing. 4.4. Staff meteorologists continuously monitor and advise Crew Chief of potential for strong surface winds during operations. 4.5. Non-essential personnel are not allowed in Hazard areas.

CONTROLS VERIFICATION

1.1.1. Formal monthly and semi-annual quality reviews conducted with balloon manufacturer by NASA management and CSBF Balloon Quality Engineer. 1.1.2. Presence of CSBF quality assurance inspectors in the balloon plant during production of all NASA balloons. 1.2.1. CSBF management review of personnel training through documented Balloon Technician career path. 1.3.1. Documented material and production quality control and quality assurance program during balloon manufacturing. 1.3.2. Presence of CSBF quality assurance inspectors in the balloon plant during production of all NASA balloons. 1.4.1. Staff meteorologist skilled in micro-meteorological phenomena is present during each operation. 1.5.1. Hazard area enforced by OSS / Mission Range Safety Officer (MRSO). 2.1.1. Formal monthly and semi-annual quality reviews conducted with balloon manufacturer by NASA management and CSBF Balloon Quality Engineer. 2.1.2. Presence of CSBF quality assurance inspectors in the balloon plant during production of all NASA balloons. 2.2.1. CSBF management review of personnel training through documented Balloon Technician career path. 2.3.1. Documented material and production quality control and quality assurance program during balloon manufacturing. 2.3.2. Presence of CSBF quality assurance inspectors in the balloon plant during production of all NASA balloons. 2.4.1. Staff meteorologist skilled in micro-meteorological phenomena is present during each operation. 2.5.1. Hazard area enforced by OSS / MRSO. 3.1.1. Formal monthly and semi-annual quality reviews conducted with balloon manufacturer by NASA management and CSBF Balloon Quality Engineer. 3.1.2. Presence of CSBF quality assurance inspectors in the balloon plant during production of all NASA balloons. 3.2.1. CSBF management review of personnel training through documented Balloon Technician career path. 3.3.1. Documented material and production quality control and quality assurance program during balloon manufacturing. 3.3.2. Presence of CSBF quality assurance inspectors in the balloon plant during production of all NASA balloons. 3.4.1. Staff meteorologist skilled in micro-meteorological phenomena is present during each operation. 3.5.1. Hazard area enforced by OSS / MRSO. 4.1.1. Formal monthly and semi-annual quality reviews conducted with balloon manufacturer by NASA management and CSBF Balloon Quality Engineer. 4.1.2. Presence of CSBF quality assurance inspectors in the balloon plant during production of all NASA balloons. 4.2.1. CSBF management review of personnel training through documented Balloon Technician career path. 4.3.1. Documented material and production quality control and quality assurance program during balloon manufacturing. 4.3.2. Presence of CSBF quality assurance inspectors in the balloon plant during production of all NASA balloons. 4.4.1. Staff meteorologist skilled in micro-meteorological phenomena is present during each operation. 4.5.1. Hazard area enforced by OSS / MRSO.

VERIFICATION STATUS

1.1.1. CLOSED. 1.1.2. CLOSED. 1.2.1. CLOSED. 1.3.1. CLOSED. 1.3.2. CLOSED. 1.4.1. CLOSED. 1.5.1. CLOSED. 2.1.1. CLOSED. 2.1.2. CLOSED. 2.2.1. CLOSED. 2.3.1. CLOSED. 2.3.2. CLOSED. 2.4.1. CLOSED. 2.5.1. CLOSED. 3.1.1. CLOSED. 3.1.2. CLOSED. 3.2.1. CLOSED. 3.3.1. CLOSED. 3.3.2. CLOSED. 3.4.1. CLOSED. 3.5.1. CLOSED. 4.1.1. CLOSED. 4.1.2. CLOSED. 4.2.1. CLOSED. 3.3.1. CLOSED. 4.3.2. CLOSED. 4.4.1. CLOSED. 4.5.1. CLOSED.

INITIAL RISK SEVERITY I ***INTERIM RISK SEVERITY*** I

INITIAL MISHAP PROBABILITY B ***INTERIM MISHAP PROBABILITY*** D

INITIAL RISK ASSESSMENT CODE 1 ***INTERIM RISK ASSESSMENT CODE*** 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Reviewed January 2016 by Z. Moore, no changes.

HAZARD REPORT NUMBER Balloon HR-9

PROJECT Balloon ***AUTHOR*** Maxfield/Ball

ID 232 ***LAST MODIFIED*** 1/20/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Spool Vehicle Hits Crew Member during Inflation

HAZARD DESCRIPTION
Personnel injured by spool vehicle as it moves forward during balloon inflation operation.

HAZARD CAUSE
1. Crew member is unaware of spool movement. 2. Crew member is not in the proper location. 3. Misunderstood communication between the driver and crew chief.

HAZARD EFFECTS
Death or Injury

HAZARD CONTROLS
1.1. Crew member is alerted before spool vehicle begins to move. 1.2. Recurrent training of launch crew members on communication protocol. 2.1. Recurrent training of launch crew members on operational safety procedures. 2.2. Crew Chief positions himself in front a spool during movement which allows for an unobstructed view of all crew members in the vicinity of the moving spool. 2.3. OSS verifies Crew members are in correct positions. 3.1. Recurrent training of launch crew members on communication protocol.

CONTROLS VERIFICATION
1.1.1. Review of personnel training records to verify recurrent training on communication protocol. 1.2.1. Review of personnel training records to verify recurrent training on operational safety procedures. 2.1.1. Review of personnel training records to verify recurrent training on operational safety procedures. 2.2.1. Monitoring of spool movement operation by Crew Chief and OSS. 2.3.1. OSS verification. 3.1.1. Review of personnel training records to verify recurrent training on communication protocol.

VERIFICATION STATUS
1.1.1. CLOSED. 1.2.1. CLOSED. 2.1.1. CLOSED. 2.2.1. CLOSED. 2.3.1. CLOSED. 3.1.1. CLOSED.

INITIAL RISK SEVERITY I

INITIAL MISHAP PROBABILITY B

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY I

INTERIM MISHAP PROBABILITY D

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Reviewed January 2016 by Z. Moore, no changes.

HAZARD REPORT NUMBER Balloon HR-10

PROJECT Balloon ***AUTHOR*** Maxfield/Ball

ID 233 ***LAST MODIFIED*** 1/20/2010

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Balloon Shucker injured by Balloon Motion

HAZARD DESCRIPTION
Balloon shucker injured due to excessive balloon rotation/movement during launch operations.

HAZARD CAUSE
1. Excessive wind causes the balloon bubble to rotate and sway, striking shucker and causing direct injury or fall from the spool vehicle.

HAZARD EFFECTS
Injury

HAZARD CONTROLS
1.1. On site meteorologist monitoring conditions with surface anemometers and pilot balloons provides wind alerts and advisories to Crew Chief. 1.2. Crew Chief monitors balloon bubble movement continuously during inflation and will clear the area of personnel if balloon movement presents a safety hazard. 1.3. Campaign Manager monitors balloon bubble movement continuously during inflation and will clear the area of personnel if balloon movement presents a safety hazard. 1.4. OSS monitors balloon bubble movement continuously during inflation and will clear the area of personnel if balloon movement presents a safety hazard.

CONTROLS VERIFICATION
1.1.1. Staff meteorologist skilled in micro-meteorological phenomena and wind forecasting is present during each operation. 1.2.1. Review of personnel training records to verify recurrent training on operational safety procedures. 1.3.1. Review of personnel training records to verify recurrent training on operational safety procedures. 1.4.1. OSS verification.

VERIFICATION STATUS
1.1.1. CLOSED. 1.2.1. CLOSED. 1.3.1. CLOSED. 1.4.1. CLOSED.

INITIAL RISK SEVERITY II

INITIAL MISHAP PROBABILITY B

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY II

INTERIM MISHAP PROBABILITY C

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY II

FINAL MISHAP PROBABILITY D

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Reviewed January 2016 by Z. Moore, no changes.

HAZARD REPORT NUMBER Balloon HR-11

PROJECT Balloon ***AUTHOR*** Maxfield/Ball/Moore/Garde

ID 234 ***LAST MODIFIED*** 2/26/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Loss of Balloon Control due to Strong Winds

HAZARD DESCRIPTION
Balloon ripped from moorings due to sustained or sudden/unexpected strong low level winds during launch operations.

HAZARD CAUSE
1. Inaccurate pre-inflation weather forecast. 2. Failure of Crew Chief/Campaign Manager to abandon or abort launch attempt in unacceptable launch conditions. 3. Failure of MRSO to call for abort, in the event that the Crew Chief or Campaign Manager do not, when launch conditions become unacceptable. 4. Unsuccessful abort resulting from BTS failure.

HAZARD EFFECTS
Death, Injury or Property Damage

HAZARD CONTROLS
1.1. On-site meteorologist monitors conditions & provides wind alerts/advisories to Crew Chief. 1.2. Crew Chief monitors weather reports & balloon bubble movement continuously during inflation & clears area of personnel if weather or balloon movement presents a safety hazard. 1.3. Campaign Manager monitors balloon bubble movement continuously; clears area if balloon movement presents a safety hazard. 1.4. OSS monitors balloon bubble movement & clears area if balloon movement presents a safety hazard. 2.1. Crew Chief authorized to abort launch attempt if inflation or launch conditions are unsafe. 2.2. Crew Chief is a skilled position requiring several years of training & experience; skills include recognizing unsafe launch conditions. 2.3. Campaign Manager authorized to abort launch attempt if inflation or launch conditions are unsafe. 2.4. Campaign Manager is a skilled position requiring training & experience; skills include recognizing unsafe launch conditions. 3.1. MRSO maintains contact with Campaign manager during launch operations. 3.2. MRSO has safety jurisdiction over all hazardous operations & may call for abort in the event that the Crew Chief or Campaign Manager does not. 4.1. BTS successfully completed annual environmental testing. 4.2. All environmental test data reviewed and documented. 4.3. Successful completion of functional testing (pre-shipment, preflight and on flight line).

CONTROLS VERIFICATION
1.1.1 Staff meteorologist, skilled in micro-meteorological phenomena and wind forecasting, is present during each operation. 1.1.2. Meteorologist uses surface anemometers and pilot balloons to monitor wind conditions continuously. 1.1.3. Meteorologist maintains constant communication with Crew Chief. 1.2.1. Training & experience. 1.3.1. Training & experience. 1.4.1. OSS action. 2.1.1. Crew Chief action. 2.2.1. Training & experience. 2.3.1. Campaign Manager Action. 2.4.1. Training & experience. 3.1.1. MRSO verification. 3.2.1. MRSO action. 4.1.1. Annual environmental testing completed by trained personnel. 4.2.1. Data reviewed independently by BPO and documentation indicating any anomalies and corrections. 4.3.1. OSS's (in field) or cognizant individual's verification of successful functional testing.

VERIFICATION STATUS
1.1.1. CLOSED. 1.1.2. CLOSED. 1.1.3. CLOSED. 1.2.1. CLOSED. 1.3.1. CLOSED. 1.4.1. CLOSED. 2.1.1. CLOSED. 2.2.1. CLOSED. 2.3.1. CLOSED. 2.4.1. CLOSED. 3.1.1. CLOSED. 3.2.1. CLOSED. 4.1.1. CLOSED. 4.2.1. CLOSED. 4.3.1. CLOSED.

INITIAL RISK SEVERITY I

INITIAL MISHAP PROBABILITY B

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY I

INTERIM MISHAP PROBABILITY C

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Updated MRSO, OSS functions and added BPO to 4.2.1. Reviewed February 2016 by Z. Moore and G. Garde, no additional changes.

HAZARD REPORT NUMBER Balloon HR-12

PROJECT Balloon ***AUTHOR*** Maxfield/Ball/Moore/GARDE

ID 235 ***LAST MODIFIED*** 2/8/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Loss of Balloon due to Strong Winds

HAZARD DESCRIPTION
Balloon bubble is blown to the ground by a sudden/unexpected, strong, low-level wind during launch operations resulting in debris or the balloon striking operations personnel.

HAZARD CAUSE
1. Inaccurate pre-inflation weather forecast. 2. Failure of Crew Chief to maintain sufficient lift in balloon bubble.

HAZARD EFFECTS
Death, Injury or Property Damage

HAZARD CONTROLS
1.1. Skilled staff meteorologist is on-site to monitor conditions during each launch operation. 1.2. Meteorologist provides real-time wind alerts and advisories to Crew Chief. 2.1. Crew Chief uses a cone angle template throughout inflation to insure adequate lift is in the bubble. 2.2. Crew Chief monitors balloon bubble movement continuously during inflation and clears the area of personnel if the balloon is in danger of being blown to the ground. 2.3. Campaign Manager monitors balloon bubble movement & clears area as needed. 2.4. OSS monitors balloon bubble movement & clears area as needed.

CONTROLS VERIFICATION
1.1.1. Staff meteorologist is skilled in micro-meteorological phenomena and wind forecasting. 1.2.1. Meteorologist is in constant communication with Crew Chief throughout launch operation. 2.1.1. Crew Chief is trained in use of cone angle template. 2.2.1. Crew Chief is a skilled position requiring several years of training & experience; skills include recognizing unsafe launch conditions. 2.3.1. Campaign Manager is a skilled position requiring training & experience; skills include recognizing unsafe launch conditions. 2.4.1. MRSO has safety jurisdiction over all hazardous operations & may call for abort in the event that the Crew Chief or Campaign Manager does not.

VERIFICATION STATUS
1.1.1. CLOSED. 1.2.1. CLOSED. 2.1.1. CLOSED. 2.2.1. CLOSED. 2.3.1. CLOSED. 2.4.1. CLOSED.

INITIAL RISK SEVERITY I

INITIAL MISHAP PROBABILITY B

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY I

INTERIM MISHAP PROBABILITY D

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Updated OSS to MRSO in 2.4.1. Reviewed February 2016 by Z. Moore and G. Garde, no additional changes.

HAZARD REPORT NUMBER Balloon HR-14

PROJECT Balloon ***AUTHOR*** Maxfield/Ball/Moore/Garde

ID 237 ***LAST MODIFIED*** 2/8/2016

HAZARDOUS SUBSYSTEM/OPERATION

Balloon Launch Operations

HAZARD DESCRIPTOR

Insufficient Lift in Balloon System

HAZARD DESCRIPTION

Helium valve not closed at inflation start; helium escapes & lift is insufficient for launch resulting in balloon falling on personnel.

HAZARD CAUSE

1. Malfunction of helium valve. 2. Helium valve “close” command not sent following flight line checkout. 3. Tear in inflation tube at connection or along length.

HAZARD EFFECTS

Death, Injury or Property Damage

HAZARD CONTROLS

1.1. Helium valve design approved by NASA/WFF Applied Engineering Tech. Directorate (AETD). 1.2. Helium valve parts produced from a documented manufacturing drawing package. 1.3. Helium valves are bench checked prior to putting them into service. 1.4. Following installation in the balloon during the launch operations, helium valves undergo a functional check through all parachute and balloon wiring. 2.1. The final step in the valve test is a checklist item indicating concurrence that the valves are closed. 2.2. Helium valves equipped with limit switches which toggle “open” or “closed” status to ground station software; when helium valve limit switch is in “open” status, text on ground station flight data monitors turns red. Valve closure is confirmed visually and through software. 3.1. Inflation tubes undergo control/quality assurance process at factory. 3.2. Visual inspection of inflation tubes during preparation. 3.3. Helium valve and inflation port design approved by NASA AETD. 3.4. For SPB balloons, written procedure installs the inflation tubes onto the inflation cans.

CONTROLS VERIFICATION

1.1.1. NASA/WFF/AETD engineering acceptance. 1.2.1. Manufacturing standards. 1.3.1. Standard CSBF procedure. 1.3.2. Recurrent training of launch crew members on operational procedures. 1.3.3. Colored sticker system on valves indicates that they have been properly bench checked. 1.4.1. Flight line helium valve installation is part of documented Balloon Technician career ladder process. 1.4.2. Electrical functional checks on the flight line are part of CSBF Electronics Technician OJT training program. 2.1.1. Standard CSBF procedure. 2.1.2. Recurrent training of launch crew members on operational procedures. 2.2.1. Standard CSBF design parameter. 2.2.2. Recurrent training of launch crew members on operational procedures. 3.1.1. Standard production procedures and QA sign-offs. 3.2.1. Launch operations personnel trained to perform visual inspection. 3.3.1. NASA/WFF/AETD engineering acceptance. 3.4.1. Launch operations personnel trained to perform operation. 3.4.2. Procedures reviewed and approved.

VERIFICATION STATUS

1.1.1. CLOSED. 1.2.1. CLOSED. 1.3.1. CLOSED. 1.3.2. CLOSED. 1.3.3. CLOSED. 1.4.1. CLOSED. 1.4.2. CLOSED. 2.1.1. CLOSED. 2.1.2. CLOSED. 2.2.1. CLOSED. 2.2.2. CLOSED. 3.1.1. CLOSED. 3.2.1. CLOSED. 3.3.1. CLOSED. 3.4.1. CLOSED. 3.4.2. CLOSED.

INITIAL RISK SEVERITY I

INITIAL MISHAP PROBABILITY C

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY I

INTERIM MISHAP PROBABILITY D

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Updated AETD, 3.4 and deleted 3.5 series. Reviewed February 2016 by Z. Moore and G. Garde, no additional changes.

HAZARD REPORT NUMBER Balloon HR-15

PROJECT Balloon ***AUTHOR*** Maxfield/Ball

ID 238 ***LAST MODIFIED*** 1/21/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Universal Terminate Package (UTP) Damaged During Launch

HAZARD DESCRIPTION
UTP strikes the ground when balloon released from spool

HAZARD CAUSE
1. Stored energy in the flight train is released after the balloon is released from the spool, causing the UTP to fall and strike the ground, damaging the UTP and disabling the helium valve, leading to an inability to terminate the balloon flight or perform parachute release functions.

HAZARD EFFECTS
Death, Injury or Property Damage

HAZARD CONTROLS
1.1. A large mattress is placed on the ground under the UTP during the launch operation to minimize the shock if the UTP drops to the ground. 1.2. On some flights, a low altitude aneroid switch, independent of the UTP, will terminate the flight if it descends below a set altitude after reaching altitude. 1.3. The UTP as part of the BTS goes through annual environmental testing including data collection and documentation whether flown or not. 1.4. The BTS system goes through several functional tests both pre-shipment and in the field to ensure operation.

CONTROLS VERIFICATION
1.1.1. Placement of the mattress is part of the Crew Chief's pre-launch checklist. 1.2.1. Low altitude switches are tested in thermo vacuum chambers prior to being put in service. 1.3.1. Annual environmental testing completed by trained personnel. 1.3.2. Data reviewed independently and documentation indicating any anomalies and corrections. 1.4.1. OSS's (in field) or cognizant individual's verification of successful functional testing.

VERIFICATION STATUS
1.1.1. CLOSED. 1.2.1. CLOSED. 1.3.1. CLOSED. 1.3.2. CLOSED. 1.4.1. CLOSED.

INITIAL RISK SEVERITY I

INITIAL MISHAP PROBABILITY B

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY I

INTERIM MISHAP PROBABILITY D

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Reviewed January 2016 by Z. Moore, no changes.

HAZARD REPORT NUMBER Balloon HR-16

PROJECT Balloon ***AUTHOR*** Maxfield/Ball

ID 239 ***LAST MODIFIED*** 1/21/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Flight Train Wiring Damaged due to Impact or Scraping on the Ground

HAZARD DESCRIPTION
Premature EED firing or inability to terminate flight due to short in flight train caused by ground impact, or rolling off ground cloth, in cross wind launches.

HAZARD CAUSE
1. Improper strain relief of flight train cabling. 2. Improper protection of flight train cabling. 3. Crew Chief begins moving the launch vehicle before the flight train is off the ground.

HAZARD EFFECTS
Death, Injury or Property Damage

HAZARD CONTROLS
1.1. Procedures for strain relief and installing wiring in the parachute are followed. 1.2. Only qualified technicians perform this function. 1.3. Flight line Lead Electronics Technician double checks all strain relief after the flight train is under tension during inflation. 2.1. A high density mattress is placed under the UTP to lessen the impact forces. 2.2. Procedures for installing wiring in the parachute and protecting exposed wiring are followed. 2.3. Only qualified technicians perform this function. 2.4. Flight line Lead Electronics Technician double checks all wire protection after the flight train is under tension during inflation. 2.5. In cross wind launches, the Crew Chief will lay down additional protective ground cloth. 3.1. Crew Chief is the only crew member riding the launch vehicle who can direct the movement of the launch vehicle. 3.2. Crew Chief leads briefing of how he plans to move the vehicle prior to balloon release with staff riding and driving the vehicle.

CONTROLS VERIFICATION
1.1.1. Standard CSBF Procedure. 1.2.1. Proper parachute wiring is part of documented Balloon Technician career path training program. 1.3.1. Recurrent training of launch crew members on operational procedures. 2.1.1. Standard CSBF Procedure. 2.2.1. Proper parachute wiring is part of documented Balloon Technician career path training program. 2.3.1. Recurrent training of launch crew members on operational procedures. 2.4.1. Proper parachute wiring is part of documented Balloon Technician career path training program. 2.5.1. Standard CSBF Procedure. 3.1.1. Standard CSBF Procedure. 3.1.2. Crew Chief training includes instruction on the importance of waiting for the flight train to clear the ground before moving the launch vehicle. 3.2.1. Recurrent training of launch crew members on operational procedures.

VERIFICATION STATUS
1.1.1. CLOSED. 1.2.1. CLOSED. 1.3.1. CLOSED. 2.1.1. CLOSED. 2.2.1. CLOSED. 2.3.1. CLOSED. 2.4.1. CLOSED. 2.5.1. CLOSED. 3.1.1. CLOSED.

INITIAL RISK SEVERITY I

INITIAL MISHAP PROBABILITY C

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY I

INTERIM MISHAP PROBABILITY D

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Reviewed January 2016 by Z. Moore, no changes.

HAZARD REPORT NUMBER Balloon HR-18

PROJECT Balloon ***AUTHOR*** Maxfield/Ball

ID 241 ***LAST MODIFIED*** 1/21/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Crew Member Falls off Launch Vehicle (LV)

HAZARD DESCRIPTION
Abrupt maneuver of Launch Vehicle Ejects Crew Member

HAZARD CAUSE
1. Unpredictable/unexpected accelerations, decelerations, and/or turns of Launch Vehicle. 2. Launch vehicle is pulled up on two wheels or overturned by excessive side loading in extreme wind conditions

HAZARD EFFECTS
Death, Injury or Property Damage

HAZARD CONTROLS
1.1. Secure seats with restraining harness provided for electronic technicians on LV. 1.2. High strength guard rails mounted on platform provide fall protection for Crew Chief and mechanical technicians. 1.3. Secure seat with seat belt provided for driver. 1.4. Crew trained to ensure restraints are fastened before first motion of LV. 1.5. All LV staff members use a central intercom headset for constant communications and awareness of instructions given to the driver. 2.1. All launch vehicles are either equipped with and extremely wide front wheel base or equipped with outriggers to prevent the vehicle from overturning or being pulled up on two wheels. 2.2. Balloon is terminated if there is loading during a launch.

CONTROLS VERIFICATION
1.1.1. Standard LV design. 1.2.1. Standard LV design. 1.3.1. Standard LV design. 1.4.1. Recurrent training of launch crew members on operational procedures. 1.5.1. Standard CSBF procedure. 1.5.2. Recurrent training of launch crew members on operational procedures. 1.5.3. A communication check is done with all crew members on the vehicle prior to balloon release. 2.1.1. CSBF mechanical engineers supervise the design and manufacture of permanent launch vehicles and design the outriggers for leased cranes to insure vehicle stability during launch. 2.2.1. Standard CSBF procedure. 2.2.2. Recurrent training of launch crew members on operational procedures. 2.2.3. Central intercom headset for constant communications and awareness.

VERIFICATION STATUS
1.1.1. CLOSED. 1.2.1. CLOSED. 1.3.1. CLOSED. 1.4.1. CLOSED. 1.5.1. CLOSED. 1.5.2. CLOSED. 1.5.3. CLOSED. 2.1.1. CLOSED. 2.2.1. CLOSED. 2.2.2. CLOSED. 2.2.3. CLOSED.

INITIAL RISK SEVERITY I

INITIAL MISHAP PROBABILITY C

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY I

INTERIM MISHAP PROBABILITY D

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Reviewed January 2016 by Z. Moore, no changes.

HAZARD REPORT NUMBER Balloon HR-19

PROJECT Balloon ***AUTHOR*** Maxfield/Ball

ID 242 ***LAST MODIFIED*** 1/21/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Flight Train Becomes Entangled in the LV

HAZARD DESCRIPTION
Cables of the Flight Train become entangled in the superstructure of the Launch Vehicle (LV)

HAZARD CAUSE
1. Launch Crew Chief maneuvers the vehicle before the flight train lifts high enough off of the ground to clear the vehicle. 2. The launch vehicle has not been properly fitted to eliminate protruding hardware that can snag the flight train. 3. Abrupt wind shift at the time of balloon release.

HAZARD EFFECTS
Injury or Property Damage

HAZARD CONTROLS
1.1. Crew Chief training emphasizes standard practices to ensure a normal payload launch. 2.1. Launch equipment certification process ensures extraneous appendages are removed from LV. 2.2. Launch equipment certification process ensures proper protection is in place prior to launch. 3.1. Staff meteorologist closely monitors wind conditions prior to launch to forecast potential changes. 3.2. Wind data is communicated to the Crew Chief and Campaign Manager real time. 3.3. Crew Chief training includes wind gust response.

CONTROLS VERIFICATION
1.1.1. Proper LV maneuvering is part of documented Balloon Technician career path training program. 1.1.2. Proper Flight Train positioning is part of documented Balloon Technician career path training program. 1.1.3. Crew Chief Training documentation. 2.2.1. LV configuration is documented and approved. 2.2.2. LECC is documented and signed off by CSBF mechanical engineer. 2.2.3. OSS verifies LV certifications and inspections. 3.1.1. Meteorologist training and experience. 3.1.2. Standard CSBF procedure. 3.1.3. Real time wind data is collected, and recorded in the “flight folder.” 3.2.1. Proper communication protocol is part of documented Balloon Meteorologist and Crew Chief career path training program. 3.2.2. Communication system is verified prior to launch operations. 3.3.1. Responsiveness to wind conditions is developed during Crew Chief training and experience.

VERIFICATION STATUS
1.1.1. CLOSED. 1.1.2. CLOSED. 1.1.3. CLOSED. 2.2.1. CLOSED. 2.2.2. CLOSED. 2.2.3. CLOSED. 3.1.1. CLOSED. 3.1.2. CLOSED. 3.1.3. CLOSED. 3.2.1. CLOSED. 3.2.2. CLOSED. 3.3.1. CLOSED.

INITIAL RISK SEVERITY II

INITIAL MISHAP PROBABILITY C

INITIAL RISK ASSESSMENT CODE 2

INTERIM RISK SEVERITY II

INTERIM MISHAP PROBABILITY D

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY II

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Reviewed January 2016 by Z. Moore, no changes.

HAZARD REPORT NUMBER Balloon HR-20

PROJECT Balloon ***AUTHOR*** Maxfield/Ball

ID 243 ***LAST MODIFIED*** 1/21/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Flight Train or Payload Impacts Launch Vehicle (LV)

HAZARD DESCRIPTION
Payload &/or Flight Train pivots about suspension point and collide or strikes LV boom

HAZARD CAUSE
1. Abrupt maneuvering of the launch vehicle. 2. Sudden wind shifts during launch. 3. Premature release of the payload.

HAZARD EFFECTS
Death, Injury or Property Damage

HAZARD CONTROLS
1.1. Pre-launch Crew Briefings include potential LV paths and maneuvers. 1.2. Mechanical Technicians on LV prevent excessive payload motion by holding tag lines attached to payload. 2.1. CSBF meteorologist closely monitors low level winds before balloon layout and inflation to help Crew Chief accurately predict the best layout direction. 2.2. CSBF meteorologist relays the real-time data to the Launch Crew Chief throughout the launch operation. 3.1. The CSBF Crew Chief training and qualification program certifies a crew chief to perform payload launches through the use of both classroom and controlled balloon launches to provide the necessary experience to make this type of real time decision.

CONTROLS VERIFICATION
1.1.1. Checklist used by Launch Crew Chief for balloon launch operations. 1.1.2. OSS Verification. 1.2.1. Standard CSBF procedure. 1.2.2. Proper payload control methods are part of documented Balloon Technician career path training program. 2.1.1. Surface and low level wind records recorded for each launch operation. 2.1.2. CSBF training and procedure. 2.2.1. Communication checks at start of launch operations. 2.2.2. CSBF training and procedure. 3.1.1. Launch Crew Chief career path training documentation in the staff employee records.

VERIFICATION STATUS
1.1.1. CLOSED. 1.1.2. CLOSED. 1.2.1. CLOSED. 1.2.2. CLOSED. 2.1.1. CLOSED. 2.1.2. CLOSED. 2.2.1. CLOSED. 2.2.2. CLOSED. 3.1.1. CLOSED

INITIAL RISK SEVERITY I

INITIAL MISHAP PROBABILITY C

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY I

INTERIM MISHAP PROBABILITY D

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Reviewed January 2016 by Z. Moore, no changes.

HAZARD REPORT NUMBER Balloon HR-21

PROJECT Balloon ***AUTHOR*** Maxfield/Ball

ID 244 ***LAST MODIFIED*** 1/21/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Payload Launch Head Release Mechanism Fails

HAZARD DESCRIPTION
Payload Release Mechanism fails to function when activated by Crew Chief resulting in payload striking the ground because of late release or breakaway.

HAZARD CAUSE
1. Degradation of release mechanism between launch campaigns. 2. Damage to mechanism during launch preparations/operations.

HAZARD EFFECTS
Death, Injury or Property Damage

HAZARD CONTROLS
1.1. Protective cover placed on launch head when not in use to protect dust and dirt accumulation. 1.2. Storage of LV between campaigns in protective environment. 1.3. Pre-launch examination and testing of the launch head including functionality, lubrication, and release pin friction testing which exceeds any loads that can be experienced during launch. 1.4. BTS was redesigned and is a totally redundant system. 2.1. Only the qualified Crew Chief performs this LV release function. 2.2. MRSO calls for an abort (initiation of BTS) within launch limits.

CONTROLS VERIFICATION
1.1.1. Standard CSBF procedure. 1.2.1. Standard CSBF procedure. 1.3.1. Pre-launch examination and testing is documented by CSBF mechanical engineer. 1.3.2. Launch head fabrication drawing package is documented to insure all launch heads are identical. 1.4.1. BTS with proven flight history endures normal qualification testing. 2.1.1. Proper release mechanism handling and activation is part of documented Balloon Crew Chief career path training program. 2.2.1. MRSO trained and has required authority.

VERIFICATION STATUS
1.1.1. CLOSED. 1.2.1. CLOSED. 1.3.1. CLOSED. 1.3.2. CLOSED. 2.1.1. CLOSED. 2.2.1. CLOSED.

INITIAL RISK SEVERITY I

INITIAL MISHAP PROBABILITY B

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY I

INTERIM MISHAP PROBABILITY C

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Reviewed January 2016 by Z. Moore, no changes.

HAZARD REPORT NUMBER Balloon HR-22

PROJECT Balloon ***AUTHOR*** Maxfield/Ball

ID 245 ***LAST MODIFIED*** 1/21/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Payload Released Too Late

HAZARD DESCRIPTION
Balloon payload strikes ground and is damaged due to late release.

HAZARD CAUSE
1. Unexpected changes in wind speed and direction during the launch operation. 2. Error in judgment by crew member.

HAZARD EFFECTS
Injury or Property Damage

HAZARD CONTROLS
1.1 The meteorologist performs surface and low level wind data collection to accurately forecast wind shifts. 1.2. The meteorologist performs real time surface and low level wind data assessments and keeps the Crew Chief advised of changes. 2.1. Crew Chief is the only crew member allowed to direct release of the payload.

CONTROLS VERIFICATION
1.1.1. The meteorologist has a defined set of parameters and low level wind soundings to perform prior to each launch. 1.2.1. Standard CSBF policy. 1.2.2. Voice communications checked and verified at start of launch operations. 2.1.1. The Crew Chief has been trained through actual mentored launches to accurately time the release of the payload from the launch vehicle. 2.1.2. CSBF career training program for Crew Chiefs insures skills are adequate to prevent this hazard.

VERIFICATION STATUS
1.1.1. CLOSED. 1.2.1. CLOSED. 1.2.2. CLOSED. 2.1.1. CLOSED. 2.1.2. CLOSED.

INITIAL RISK SEVERITY II

INITIAL MISHAP PROBABILITY B

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY II

INTERIM MISHAP PROBABILITY C

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY II

FINAL MISHAP PROBABILITY D

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Reviewed January 2016 by Z. Moore, no changes.

HAZARD REPORT NUMBER Balloon HR-23

PROJECT Balloon ***AUTHOR*** Maxfield/Ball/Moore

ID 246 ***LAST MODIFIED*** 1/21/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Launch Vehicle (LV) Breakdown (includes stuck on pad)

HAZARD DESCRIPTION
Payload not placed under balloon when directed because LV immobilized resulting in payload damaged during release and abort.

HAZARD CAUSE
1. Equipment failure. 2. Driver error. 3. Launch Pad surface irregularities.

HAZARD EFFECTS
Injury or Property Damage

HAZARD CONTROLS
1.1. Preventative maintenance program on all launch vehicles. 1.2. Launch Vehicle is started and checked immediately prior to balloon release from the spool. 2.1. Launch vehicle drivers are formally trained as part of the Balloon Technician training. 2.2. Launch vehicle driving tests are performed at the beginning of each campaign. 3.1. Launch pad preparation including clearing, leveling, etc.

CONTROLS VERIFICATION
1.1.1. Documented maintenance program for all permanent launch vehicles. 1.2.1. Standard CSBF launch operations procedure. 2.1.1. Documented driver training program. 2.2.1. Documented driver certification program. 3.1.1. Launch Pad inspected prior to each launch operation to ensure no issues.

VERIFICATION STATUS
1.1.1. CLOSED. 1.2.1. CLOSED. 2.1.1. CLOSED. 2.2.1. CLOSED. 3.1.1. CLOSED.

INITIAL RISK SEVERITY II

INITIAL MISHAP PROBABILITY B

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY II

INTERIM MISHAP PROBABILITY C

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY II

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Edited 2.1. Reviewed January 2016 by Z. Moore, no additional changes.

HAZARD REPORT NUMBER Balloon HR-24

PROJECT Balloon ***AUTHOR*** Maxfield/Ball/Moore

ID 247 ***LAST MODIFIED*** 1/20/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Personnel/Equipment Run Over by LV During or After Launch

HAZARD DESCRIPTION
Non-participating staff, scientists, or observers are struck by moving launch vehicle or balloon

HAZARD CAUSE
1. Non-essential personnel in the hazard area. 2. Improper spectator control. 3. Launch Vehicle exits operations area.

HAZARD EFFECTS
Death, Injury or Property Damage

HAZARD CONTROLS
1.1. Clearing Operations Area of non-essential personnel is part of the Launch Countdown. 1.2. OSS verifies area has been cleared. 2.1. Operations area is surrounded by buffer of sufficient margin to protect spectators outside that perimeter. 2.2. Perimeter check for out-of-place/unauthorized spectators is performed before Launch Countdown begins. 2.3. Road blocks are set up and manned by assigned personnel, or law officers, to prevent vehicles or personnel from entering hazardous areas. 3.1. The Operations Area, specific to each launch site, is defined in the pre-mission briefing. 3.2. Launch Vehicle (LV) drivers familiarize themselves with Ops Area limits before launch ops begin. 3.3. If the launch vehicle is in danger of running out of the area, the flight is aborted. 3.4. Hazards, restrictions, ops area and plans for crowd control are briefed in the Haz-Op briefing, by the OSS/MRSO.

CONTROLS VERIFICATION
1.1.1. Standard Operations Procedure (SOP). 1.2.1. OSS verification. 2.1.1. Engineering and operational analysis used to establish parameters for the launch operations area. 2.1.2. Launch operations area and buffer approved by WFF Ground Safety Office and documented in the GSP. 2.2.1. SOP. 2.2.2. OSS verification. 2.3.1. SOP. 2.3.2. OSS verification. 3.1.1. Established outline for pre-operational safety briefing to ensure all safety aspects are covered. 3.2.1. SOP. 3.3.1. SOP. 3.3.2. Proper abort procedure is part of documented Balloon Technician career path training program. 3.3.3. Recurrent training of launch crew members on abort procedures. 3.3.4. Crew Chief calls for abort if launch criteria are exceeded. 3.3.5. Campaign Manager calls for abort if Crew Chief fails to when needed. 3.3.6. OSS calls for launch abort if CM and CC fail to do so when needed. 3.4.1. SOP. 3.4.2. Established outline for pre-operational safety briefing ensures all safety aspects are covered.

VERIFICATION STATUS
1.1.1. CLOSED. 1.2.1. CLOSED. 2.1.1. CLOSED. 2.1.2. CLOSED. 2.2.1. CLOSED. 2.2.2. CLOSED. 2.3.1. CLOSED. 2.3.2. CLOSED. 3.1.1. CLOSED. 3.2.1. CLOSED. 3.3.1. CLOSED. 3.3.2. CLOSED. 3.3.3. CLOSED. 3.3.4. CLOSED. 3.3.5. CLOSED. 3.3.6. CLOSED. 3.4.1. CLOSED. 3.4.2. CLOSED.

INITIAL RISK SEVERITY I

INITIAL MISHAP PROBABILITY B

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY I

INTERIM MISHAP PROBABILITY C

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Added MRSO and edited 3.3.6. Reviewed January 2016 by Z. Moore, no additional changes.

HAZARD REPORT NUMBER Balloon HR-25

PROJECT Balloon ***AUTHOR*** Maxfield/Ball

ID 248 ***LAST MODIFIED*** 1/20/2016

HAZARDOUS SUBSYSTEM/OPERATION
Balloon Launch Operations

HAZARD DESCRIPTOR
Catastrophic Balloon Failure after Spool Release/Before Payload Release

HAZARD DESCRIPTION
Failed balloon is not terminated safely and crashes to ground on personnel or equipment.

HAZARD CAUSE
1. Launch dynamics. 2. Damage induced during inflation. 3. Manufacturing/material defects in the balloon.

HAZARD EFFECTS
Death, Injury or Property Damage

HAZARD CONTROLS
1.1. Balloon inflation monitored by Crew Chief. 1.2. Crew Chief & Campaign Manager are familiar with & recognize failure mode. 1.3. Crew Chief trained to call for abort. 1.4. Campaign Manager can call for abort if Crew Chief does not. 1.5. Terminate commands are sent and the balloon is released from the flight train without the payload being released. 1.6. Campaign Manager and Crew Chief have voice communication during the launch on independent radio frequency. 2.1. Balloon inflation monitored by Crew Chief. 2.2. Crew Chief & Campaign Manager are familiar with & recognize failure mode. 2.3. Crew Chief trained to call for abort. 2.4. Campaign Manager can call for abort if Crew Chief does not. 2.5. Terminate commands are sent and the balloon is released from the flight train without the payload being released. 2.6. Campaign Manager and Crew Chief have voice communication during the launch on independent radio frequency. 3.1. Documented material and production quality control and quality assurance program. 3.2. Independent Quality Assurance surveillance by CSBF technicians at the balloon plant.

CONTROLS VERIFICATION
1.1.1. SOP. 1.1.2. Training. 1.2.1. Training and experience. 1.3.1. Training and experience. 1.4.1. Campaign Manager authorization. 1.5.1. Documented procedure on launch and launch aborts prior to release of payload. 1.6.1. SPO. 1.6.2. Voice Communications check at start of launch ops. 2.1.1. SOP. 2.1.2. Training. 2.2.1. Training and experience. 2.3.1. Training and experience. 2.4.1. Campaign Manager authorization. 2.5.1. Documented procedure on launch and launch aborts prior to release of payload. 2.6.1. SPO. 2.6.2. Voice Communications check at start of launch ops. 3.1.1. Formal monthly and semi-annual quality reviews conducted with balloon manufacturer by NASA management and CSBF Balloon Quality Engineer. 3.2.1. SOP.

VERIFICATION STATUS
1.1.1. CLOSED. 1.1.2. CLOSED. 1.2.1. CLOSED. 1.3.1. CLOSED. 1.4.1. CLOSED. 1.5.1. CLOSED. 1.6.1. CLOSED. 1.6.2. CLOSED. 2.1.1. CLOSED. 2.1.2. CLOSED. 2.2.1. CLOSED. 2.3.1. CLOSED. 2.4.1. CLOSED. 2.5.1. CLOSED. 2.6.1. CLOSED. 2.6.2. CLOSED. 3.1.1. CLOSED. 3.2.1. CLOSED.

INITIAL RISK SEVERITY I ***INTERIM RISK SEVERITY*** I

INITIAL MISHAP PROBABILITY C ***INTERIM MISHAP PROBABILITY*** D

INITIAL RISK ASSESSMENT CODE 1 ***INTERIM RISK ASSESSMENT CODE*** 2

FINAL RISK SEVERITY I

FINAL MISHAP PROBABILITY E

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Reviewed January 2016 by Z. Moore, no changes.

HAZARD REPORT NUMBER Balloon HR-26

PROJECT Balloons ***AUTHOR*** Ayers/Franco/Moore

ID 252 ***LAST MODIFIED*** 1/25/2016

HAZARDOUS SUBSYSTEM/OPERATION

Balloon Launch Operations

HAZARD DESCRIPTOR

Personnel injured by falling boom on a commercial launch crane

HAZARD DESCRIPTION

The crane boom hydraulic system fails allowing the boom to fail rapidly to the crane deck injuring people and damaging the suspended scientific payload.

HAZARD CAUSE

1. Failure of the launch boom hydraulic system.

HAZARD EFFECTS

Death, Injury or Property Damage

HAZARD CONTROLS

1.1. The telescoping boom on ALL commercial cranes leased must have at least a rated lifting capacity of 220,000 lbs in optimum configuration. CSBF suspends no more than 7,500 lbs from the boom. The Boom Luff ram (or derricking cylinder) has a fail-safe hydraulic locking valve incorporated into the main body of the hydraulic cylinder. This valve will only allow fluid to enter or exit the cylinder if it senses positive hydraulic pressure. If the hydraulic system fails catastrophically, the pressure goes to zero and the valve cannot open. Therefore, no fluid can flow out of the cylinder and cause the boom to fall rapidly. 1.2. Documented LECC (Launch Equipment Configuration Certification) process insures all launch equipment and the modified launch vehicle boom can withstand forces exerted on launch head at the maximum planned gross inflation including forces that may be induced by a 22 knot wind from behind the fully inflated balloon bubble. 1.3. The crane is boomed down by chains to restrict movement and limit upward forces exerted during the LECC, inflation, and launch process.

CONTROLS VERIFICATION

1.1.1. Prior to NASA CSBF use, leased commercial cranes undergo inspection and certification under the guidelines and regulations of the responsible authorities as required by the respective institution or country. 1.2.1. Engineering analysis and pull testing of the modified launch crane is carried out and documented at the beginning of each campaign. 1.3.1. Chains are installed on the outriggers and boom and made taut prior to operations.

VERIFICATION STATUS

1.1.1. CLOSED. 1.2.1. CLOSED. 1.3.1. CLOSED.

INITIAL RISK SEVERITY II

INITIAL MISHAP PROBABILITY B

INITIAL RISK ASSESSMENT CODE 1

INTERIM RISK SEVERITY II

INTERIM MISHAP PROBABILITY C

INTERIM RISK ASSESSMENT CODE 2

FINAL RISK SEVERITY II

FINAL MISHAP PROBABILITY D

FINAL RISK ASSESSMENT CODE 3

NOTES/COMMENTS: Updated for all commercial launch cranes and typos. Reviewed January 2016 by Z. Moore, no additional changes.